Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

MAY, 1948

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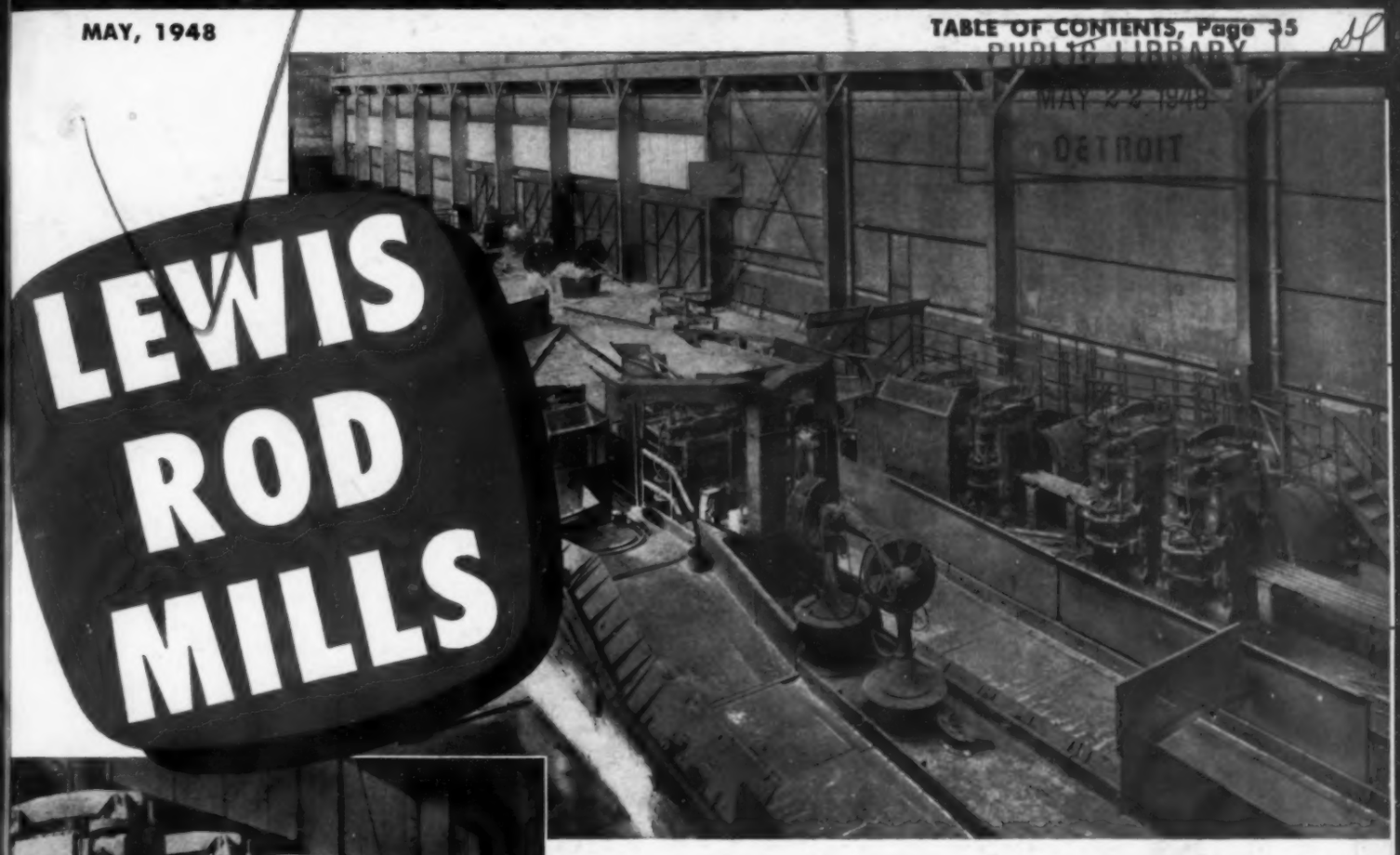


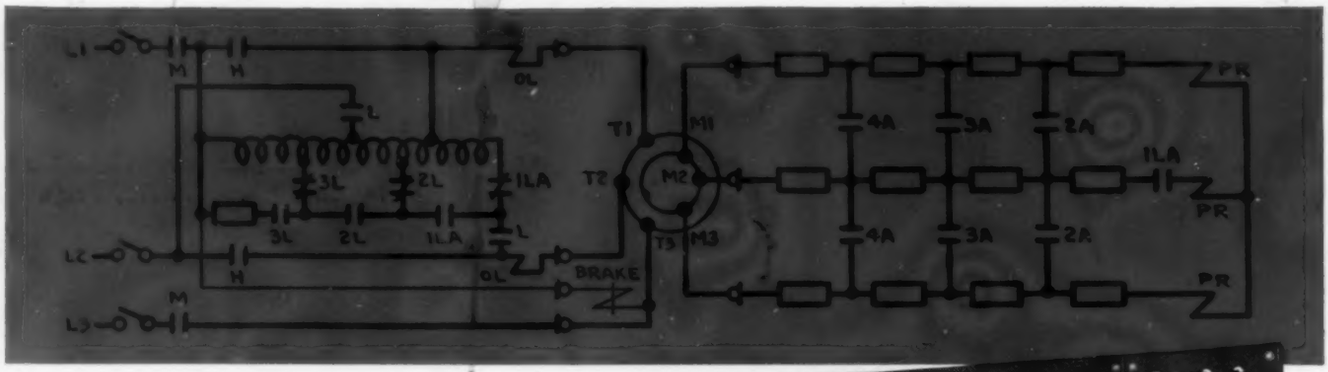
★ **HIGH TONNAGE MILLS OF GREAT FLEXIBILITY**

In both continuous and semi-continuous types, Lewis Rod Mills are designed to handle a diversified output of highly specialized alloy steels . . . Lewis engineers welcome the opportunity to develop new rolling machinery for your particular requirements.

MANUFACTURERS OF
ROLLS AND ROLLING MILL MACHINERY
FOR THE IRON, STEEL AND NON-FERROUS INDUSTRIES

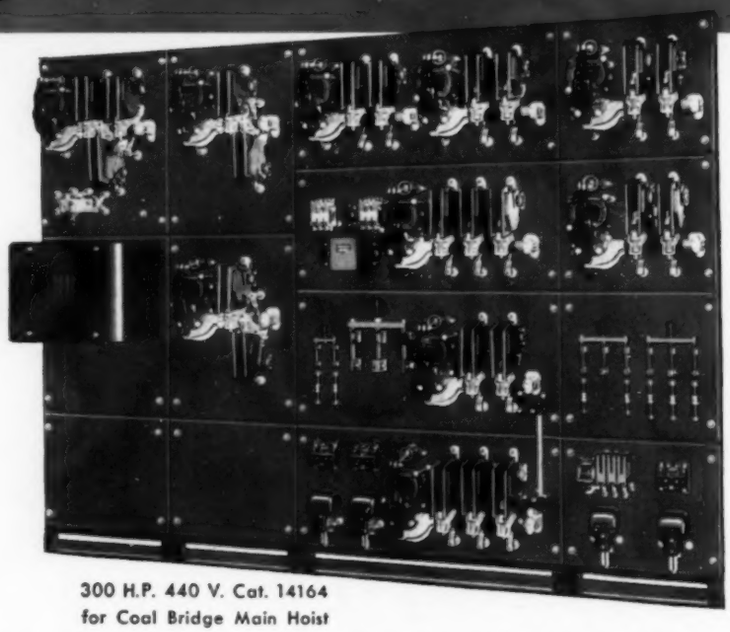
LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH, PA.

What control for what mill equipment? One of a SERIES of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it the preferred control for the steel industry.



When you want positively controlled dynamic braking on an A-c crane hoist

Then call for.....
CUTLER-HAMMER 14164 A-c Dynamic Lowering Control



300 H.P. 440 V. Cat. 14164
for Coal Bridge Main Hoist

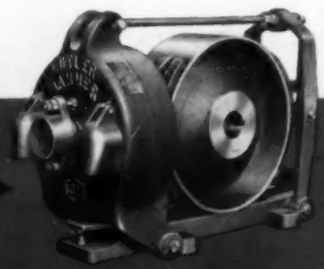
It is no longer necessary to select direct current crane motors when you want maximum crane hoist performance. Nor is it necessary to put up with costly and troublesome load lowering brakes on alternating current crane hoists.

Cutler-Hammer Bulletin 14164 A-c Dynamic Lowering Control provides, not only completely satisfactory performance in hoisting, but five stable and selective speeds in the lowering direction, accurate inching, dynamic braking, timed acceleration in both directions and timed deceleration for spotting a load.

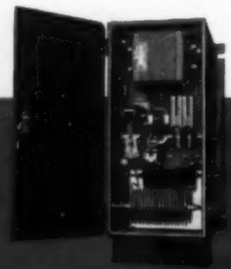
Cutler-Hammer A-c Dynamic Lowering Control can be used with any crane type slip ring motor and is available in manual and magnetic types. Specify this outstanding A-c crane control engineering development on your next crane... CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
MOTOR CONTROL
C-H

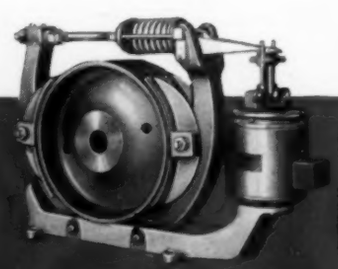
Typical Components ...of... CUTLER-HAMMER Mill Control



Famous C-H Type M D-c brake...standard for the steel industry.



Control panel with rectifier for using D-c brake with A-c crane control.



Type TM Brake (Torque Motor Operated) for A-c cranes.

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress March 3, 1879. $7.50 per year in United States, $8.25 Canada, $10.00 foreign countries. Volume 25, No. 5.

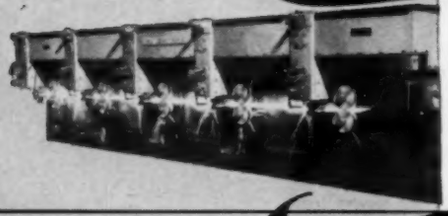
Pipe and Tube Mill Equipment by . . .

Aetna-Standard

SEAMLESS TUBE MILLS

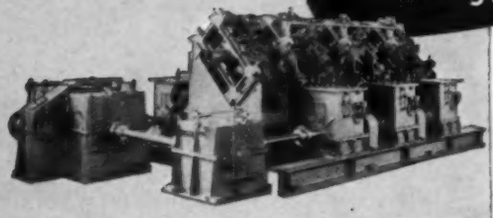
Aetna-Standard has built more seamless tube mills than any other company. We build all sizes, with drives ranging between 500 and 5000 H.P. and roll diameters between 12″ and 54″. Aetna mills produce seamless tubing up to 50 feet in length and diameters between 1½″ and 24″.

CONTINUOUS BUTTWELD PIPE MILLS



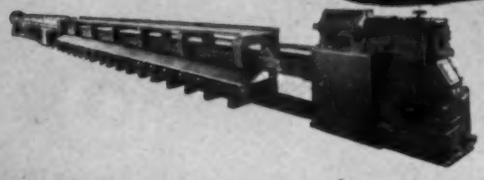
Aetna-Standard recently announced a new development . . . a 10-stand forming and welding mill. This design has several advantages over the conventional six-stand mill. Aetna ranks number one in the design and manufacture of continuous buttweld pipe mills. Range includes pipe from ½″ to 4″ dia., and speeds up to 1000 ft. per minute, with automatic cut-off.

SIZING MILLS



Builders of more sizing mills than any other company, Aetna-Standard makes these two types—closed housing and overhung rolls. Size range embraces ⅜″ to 24″ O.D. for sizing butt, lap or seamless tubes. From Aetna, you can purchase a complete mill or any unit, such as piercer, plug mill, reelers, sizing mill, or reducing mill.

DRAWBENCHES



Our range includes benches for cold drawing bars or tubes, of ferrous or non-ferrous materials (single, double or triple.) Pulling capacity embraces 1000 to 300,000 pounds. Newer developments by Aetna-Standard include: rack-type bench; dual chain bench; and triple draw.

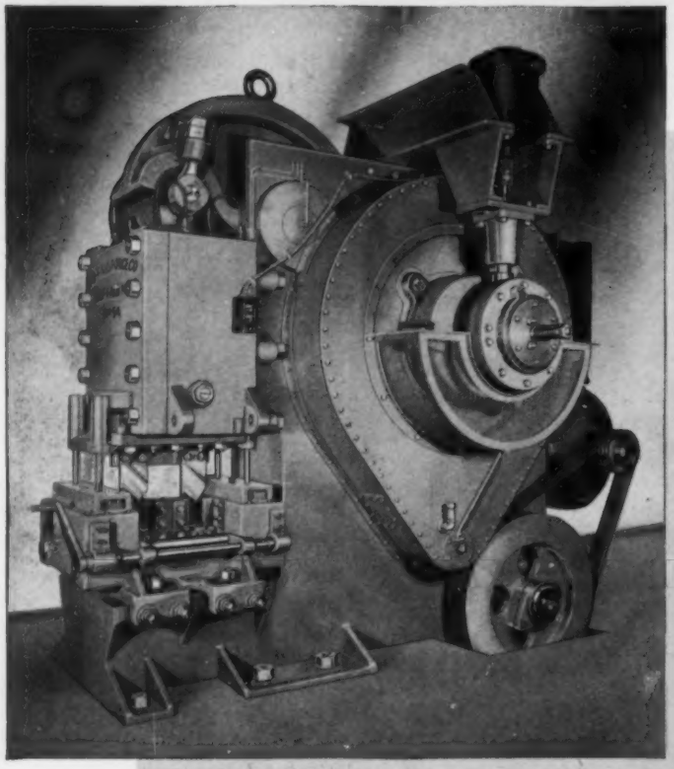
Tube Mill Equipment made by Aetna-Standard . . .

- Continuous Pipe Galvanizing Equipment
- Disc and Chain Type Cooling Beds
- Mechanical Straightening Presses
- Hydraulic Straightening Presses
- Hydraulic Squeeze Pointers
- Drawbenches
- Seamless Tube Mills
- Reducing Mills
- Piercing Mills
- Sizing Mills
- Plug Mills
- Reelers
- Continuous Buttweld Pipe Mills
- Continuous Tube Rolling Mills
- Auxiliary Finishing Equipment
- Cutting-off Machines
- Threading Machines
- Tube Mill Tables

THE AETNA-STANDARD ENGINEERING COMPANY . YOUNGSTOWN, OHIO

ASSOCIATED COMPANIES: [illegible]

FOR LOWER MANUFACTURING COSTS



Buffalo No. 54 Mill Type Shear, especially designed for "heavy-duty" service. This machine has a capacity of 210 ton with a 6" stroke.

Tooling Space on Three Sides!

UP TO 1200-TON CAPACITIES

PUNCHING - SHEARING - BLANKING

"Buffalo" Mill Type Shears fill the gap between the standard C-type punch or shear and the four-column or straight side press. Their heavier, stronger, electrically-welded steel plate frame — their longer stroke — their larger tooling space — their heavier capacities — have made them popular tools in many mills. Twelve sizes, starting with 250-ton capacity. Each size has two power stroke lengths.

You'll get square, undistorted surfaces in your cuts — with "Buffalo" Mill Type Shears!

Write for Bulletin No. 3650

BUFFALO FORGE COMPANY

173 Mortimer Street, Buffalo 5, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

MACHINE TOOLS by "Buffalo"

- BACK SPOT FACERS
- BAR CUTTERS
- BENDING ROLLS
- BILLET SHEARS
- DOUBLE END PUNCHES AND SHEARS
- LOCOMOTIVE SHEARS
- MILL TYPE SHEARS
- RAPID ACTING PUNCHES
- SINGLE END SHEARS
- SPRUE CUTTERS
- STRUCTURAL IRON WORKERS
- UNIVERSAL IRON WORKERS
- DRILLS FOR THE PRODUCTION LINE DRILLS FOR THE TOOL ROOM

CONTINUOUS SERVICE—FASTER OPERATION—PEAK ACCURACY

IF YOU HAVE ANY

HYDRAULIC

PROBLEM

CONSULT

HYDROPRESS · INC.

ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS · PUMPS

ACCUMULATORS · DIE CASTING MACHINES

566-568 LEXINGTON AVENUE · NEW YORK 22 · N. Y.

DETROIT · SAN FRANCISCO · SEATTLE · WASHINGTON, D. C.

Alliance ON THE JOB DAY-IN, DAY-OUT *24* HOURS A DAY!

Steel mills have no five o'clock whistle; they keep on producing all day, all night, month after month, year after year. That's why steel plants must have rugged, *dependable* equipment — like the sturdy Alliance Open Hearth Crane shown here. This specially-designed crane carries molten iron from the mixer to the open hearth furnace... quickly, safely, and economically... then repeats this operation over and over again, throughout the three shifts of a 24-hour day. Built for long, rugged service, Alliance cranes maintain smooth-flowing, trouble-free production schedules at lower cost per ton.

For fifty-odd years, steel mill engineers and production men have been bringing their material handling problems to Alliance. Let Alliance—*World's Largest Builder of the World's Largest Cranes*—develop the crane best suited to your plant methods and operations.

A phone call or letter will bring one of our trained engineers to your office.

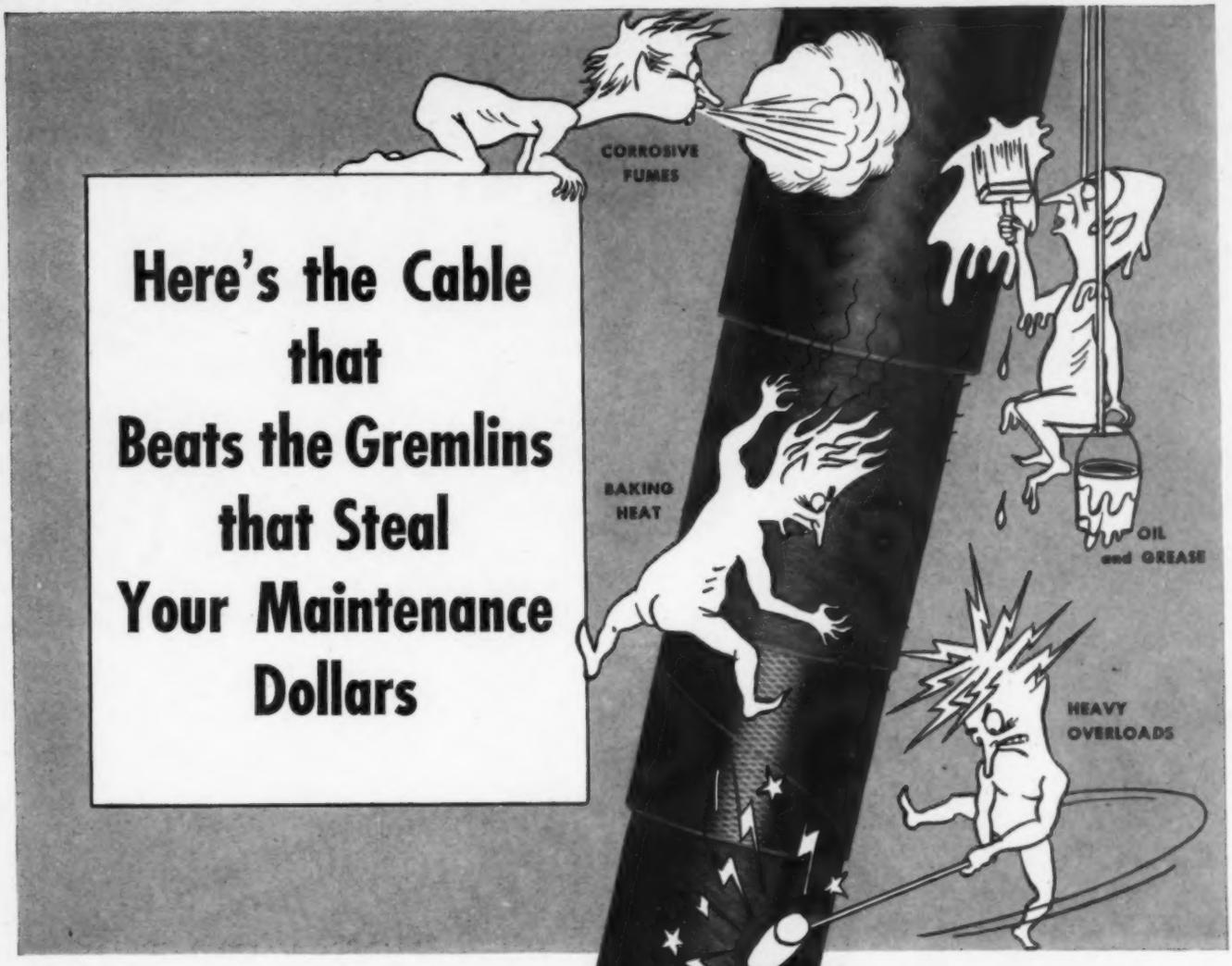
THE ALLIANCE MACHINE COMPANY

MAIN OFFICE
ALLIANCE, OHIO

PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS
SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET
CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES
SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

Alliance



Here's the Cable that Beats the Gremlins that Steal Your Maintenance Dollars

We're sure you've met the gremlins. They're the little fellows who cause the wire failures that cost you so many nightmares. But you can beat them to the punch with *permanently insulated* Rockbestos A.V.C.

For here's the cable that gives you assured trouble-free service, saves maintenance costs for you every day through all of its long dependable life.

Because it's permanently insulated with *impregnated asbestos*, Rockbestos A.V.C. won't rot or bloom when exposed to fumes, grease or oil . . . won't bake brittle when exposed to constant high temperatures up to 230° F. . . . won't break down (where others so often do!) when exposed to severe heating and cooling cycles in conduit.

Select your circuit protection from 125 Rockbestos wires and cables in 300 to 5,000 volt ratings. If you desire, the Rockbestos engineer in our nearest district office will make recommendations. Write him or write direct.

ROCKBESTOS PRODUCTS CORP., 629 NICOLL ST., NEW HAVEN 4, CONN.

NEW YORK BUFFALO CLEVELAND DETROIT CHICAGO
PITTSBURGH ST. LOUIS LOS ANGELES OAKLAND, CALIF.

Why ROCKBESTOS A.V.C. Keeps Circuits Operating Under Severe Conditions

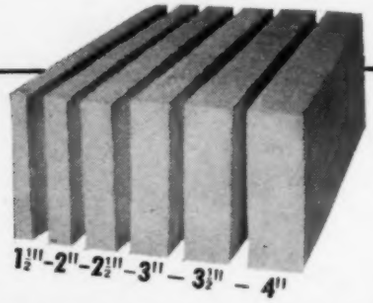
- A tough, non-aging impregnated asbestos braid resistant to heat, flame, moisture, grease, oil and corrosive fumes.
- An outer wall of impregnated felted asbestos that won't dry out, crack, flow, rot or burn —also protects varnished cambric beneath from heat and oxidation.
- Varnished cambric for high dielectric strength and added moisture resistance.
- An inner wall of heat and flame resistant impregnated asbestos which acts as a baffle between the varnished cambric and hot conductors.
- The conductor is perfectly and permanently centered in non-flowing heat resistant insulation that provides greater current carrying capacity.

WRITE TODAY—for your copy of the new No. 10-F Catalog, sectioned for easy reference to permanently insulated Lighting Wires, Power & Control Cables; Apparatus Wires & Cables; Switchboard, Appliance, Fixture, Electronic and Magnet Wires.

ROCKBESTOS A.V.C. *The Wire with Permanent Insulation*

Why the lowest cost open hearth producers use SUPEREX for regenerator insulation

The large size of the Superex blocks saves construction costs



Superex blocks are furnished in various standard sizes and thicknesses

• "Insulate with Superex and you make substantial fuel savings and obtain higher operating temperatures," that's what cost-conscious operators find.

Superex provides these savings year after year. Made of calcined diatomaceous silica and asbestos, it presents a formidable heat barrier. It maintains its high insulating efficiency indefinitely on temperatures to 1900° F. . . . does not disintegrate . . . retains its high physical strength . . . resists the stresses of open hearth and other mill operations.

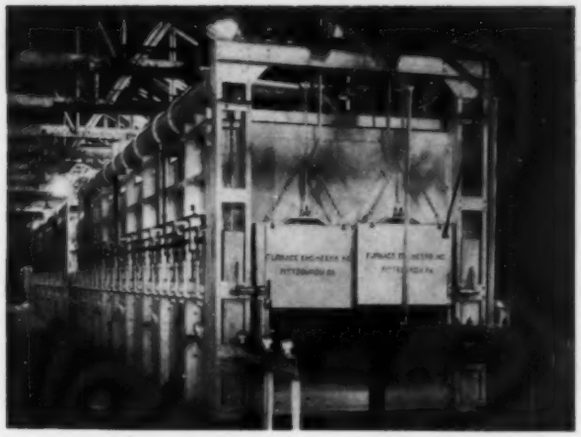
Higher operating temperatures with Superex result from its ability to reduce air infiltration. This advantage is traced to its unique structure and low permeability.

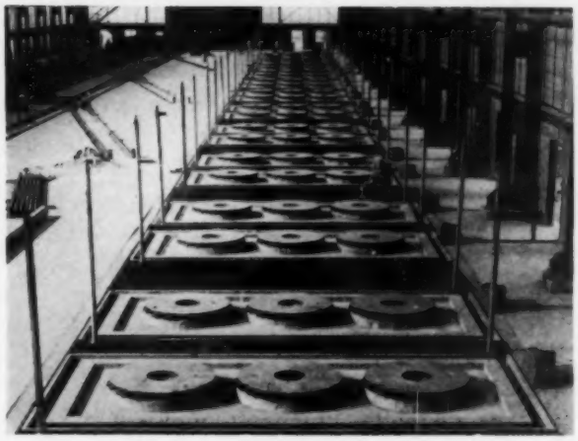
Superex is light in weight, easily cut and applied . . . comes in convenient standard sizes or may be ordered in irregular shapes.

To help you gain the greatest savings from Superex, Johns-Manville has prepared an engineering report, "Open Hearth Regenerators—a comparison of various insulation specifications." This report indicates the economic thickness of Superex to use as related to the costs of various types of fuels. To obtain this booklet, write Johns-Manville, Box 290, New York 16, N. Y.

TO OBTAIN THIS BOOKLET, WRITE
JOHNS-MANVILLE
Box 290, New York 16, N. Y.

JOHNS-MANVILLE *First in* INSULATIONS





If heat treating is your problem...

F. E. I. HAS THE ANSWER

Specialists in heat treating processes, from original analysis and design to final production operation, F. E. I. offers you a background of knowledge, experience and success for solving your heat treating problems.

Your special problem will be analyzed, the equipment you need will be designed, built, installed and tested—and turned over to you in full operation. Let us tell you what we've done for others—and what we can do for you. There's no obligation.

F. E. I. EQUIPMENT

Direct-Fired Cover Furnaces for annealing flat sheets or coils. Spheroidizing, Normalizing, and bright annealing of wire, rods, coiled strip.

For Heavy Coil Loads: Patented Convection Base, gives 2 to 4 times longer service.

For Wire, Bar and Tube Mills: Galvanizing, Patenting and Normalizing Furnaces.

For Pipe, Sheet and Job Plants: Hot Dip Galvanizing Furnaces.

Car Type Furnaces, Rod Heating, Lead Quenching, Ladle Heating and Salt Bath Descaling Furnaces.

Billet and Slab Heating Furnace.

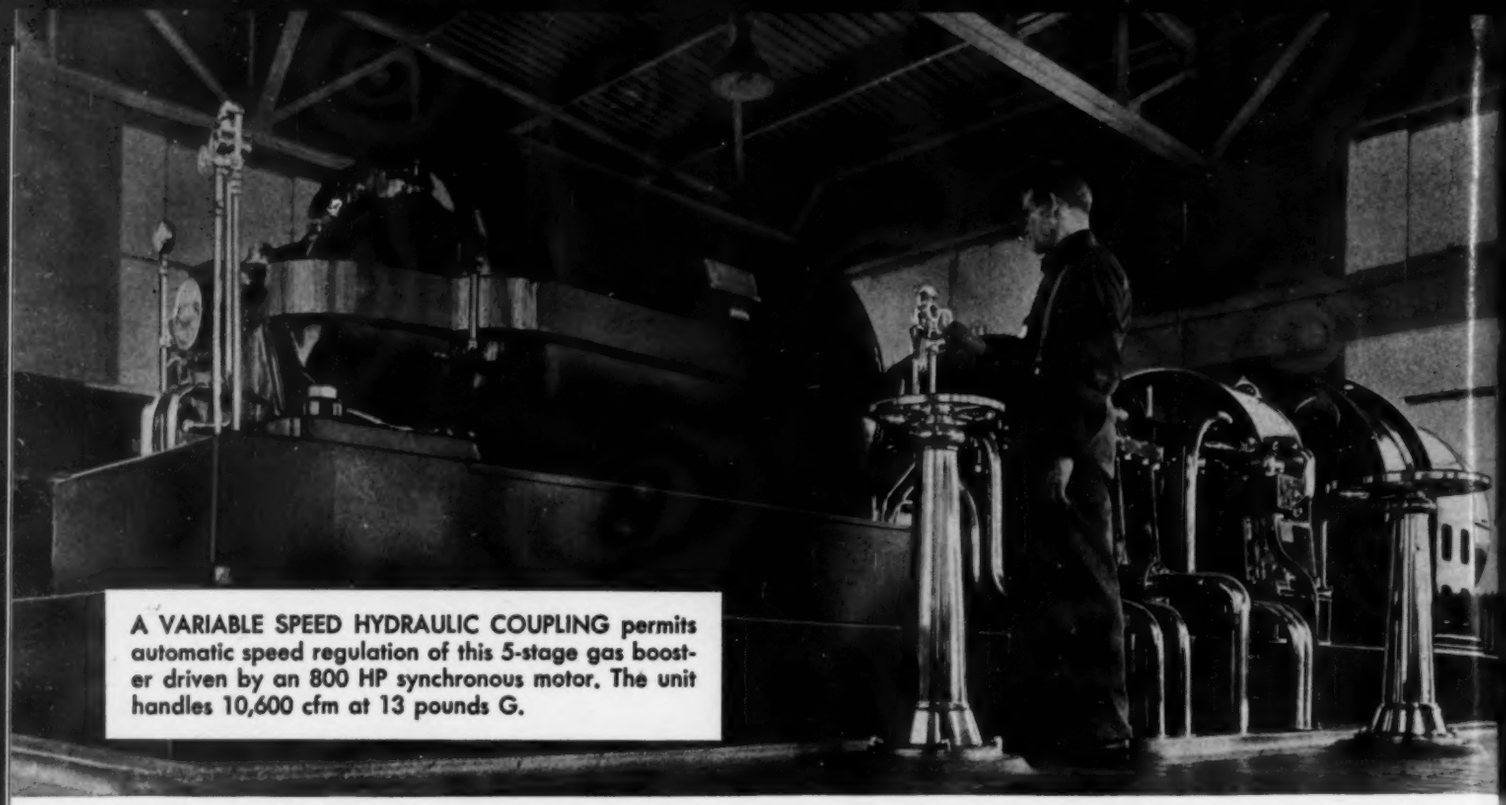
Soaking Pits.

Special Application Furnaces for both ferrous and non-ferrous industry.

FURNACE ENGINEERS, *Inc.*

FOREIGN REPRESENTATIVES: For Canada: Salem Engineering (Canada) Ltd., Toronto, Ont. For Europe, Asia: Salem Engineering Co., Ltd., 124 Devonshire Street, Sheffield 1, England.

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.



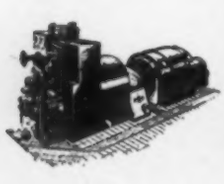
A VARIABLE SPEED HYDRAULIC COUPLING permits automatic speed regulation of this 5-stage gas booster driven by an 800 HP synchronous motor. The unit handles 10,600 cfm at 13 pounds G.

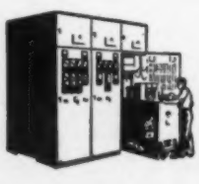
HOW TO GIVE PROFITS

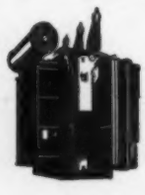
Use Newest, Efficient Allis-Chalmers Centrifugal Exhausters...Boosters in Your Modern Coke Plant!

BY ACCURATE CONTROL of driven speed, *exhausters* aid in maintaining constant pressure in coke ovens, as well as in gas collector mains — assuring maximum by-product yield. Similarly, through automatic speed regulation, *boosters* transport gas from storage for further processing, or use, at constant pressure. Both centrifugal blower applications contribute materially to *efficient* coke plant operation — add to profits.

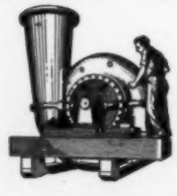
A-C BUILDS BOTH BLOWER AND DRIVE
This means a "team" designed for maximum efficiency and backed by a *single* responsibility.



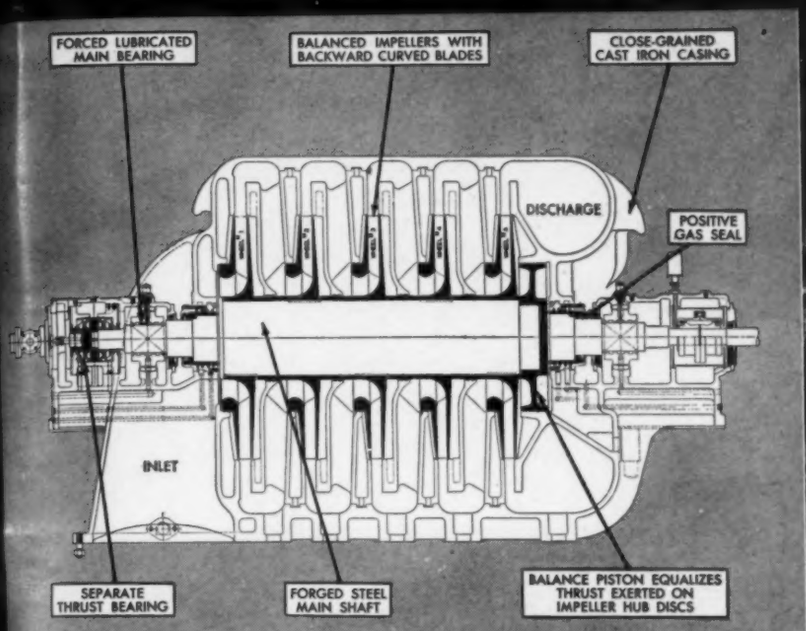




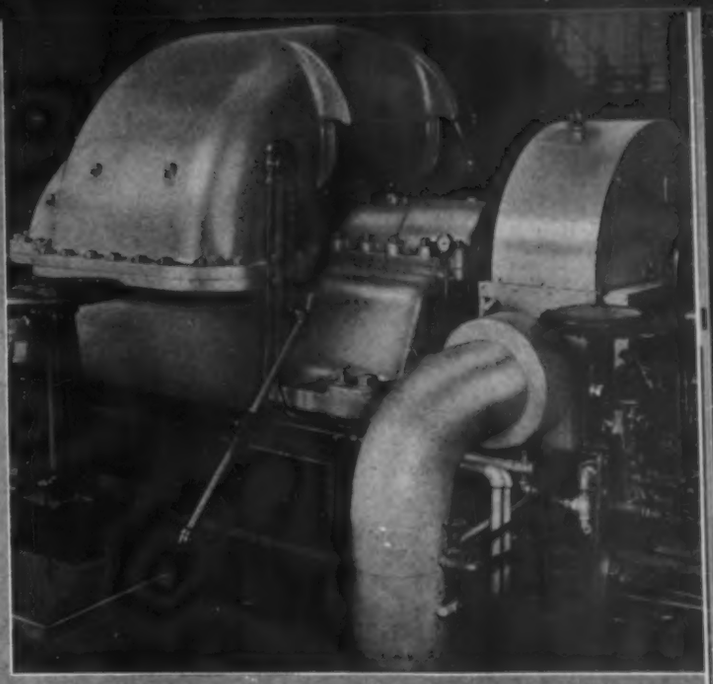
POWER & ELECTRICAL — Steam Turbines, Condensers, Water Conditioning, Power Transformers, Switchgear, Unit Substations, Circuit Breakers...



UTILIZATION & PROCESS — Motors, Blowers, Rectifiers, M-G Sets, Betatron, Pumps, Compressors, Regulex Exciters, Texrope V-Belt Drives . . .



CROSS-SECTION of a typical Allis-Chalmers centrifugal gas booster showing liberal design that means long life and low maintenance. Unit has five stages.



A 665 HP STEAM TURBINE drives this multi-stage coke oven gas exhauster at a speed of 4200 RPM. The unit handles 33,000 cubic feet of gas per minute at a pressure of 85 inches of water G.

A "BOOST!"

"TAILORED" TO THE APPLICATION

Your installation requirements determine the overall design. For example, if constant suctions or pressures are required, automatic speed control may be called for — through methods such as automatic throttling of turbine or motor speed variation met by means of a hydraulic coupling.

WHAT WE MEAN BY LIBERAL DESIGN

Casing is a special grade of close-grained cast iron assuring a sound, tight casting. It is split horizontally along centerline to facilitate dismantling. Substantial pedestals, cast integral with lower half, form the bearing supports. Suction and discharge openings are usually integral with lower half and directed downward but can be directed upward. Downward arrangement permits upper half of casing to be lifted without disturbing rotor or disconnecting piping.

The forged steel rotor shaft is carefully annealed, heat treated and machined. Impeller wheels are built up of forged steel hub and cover discs with the backward curved blades securely hand riveted between them. The completed rotor assembly is carefully balanced and given a severe over-speed test.

REPUTATION BEHIND THE PRODUCT

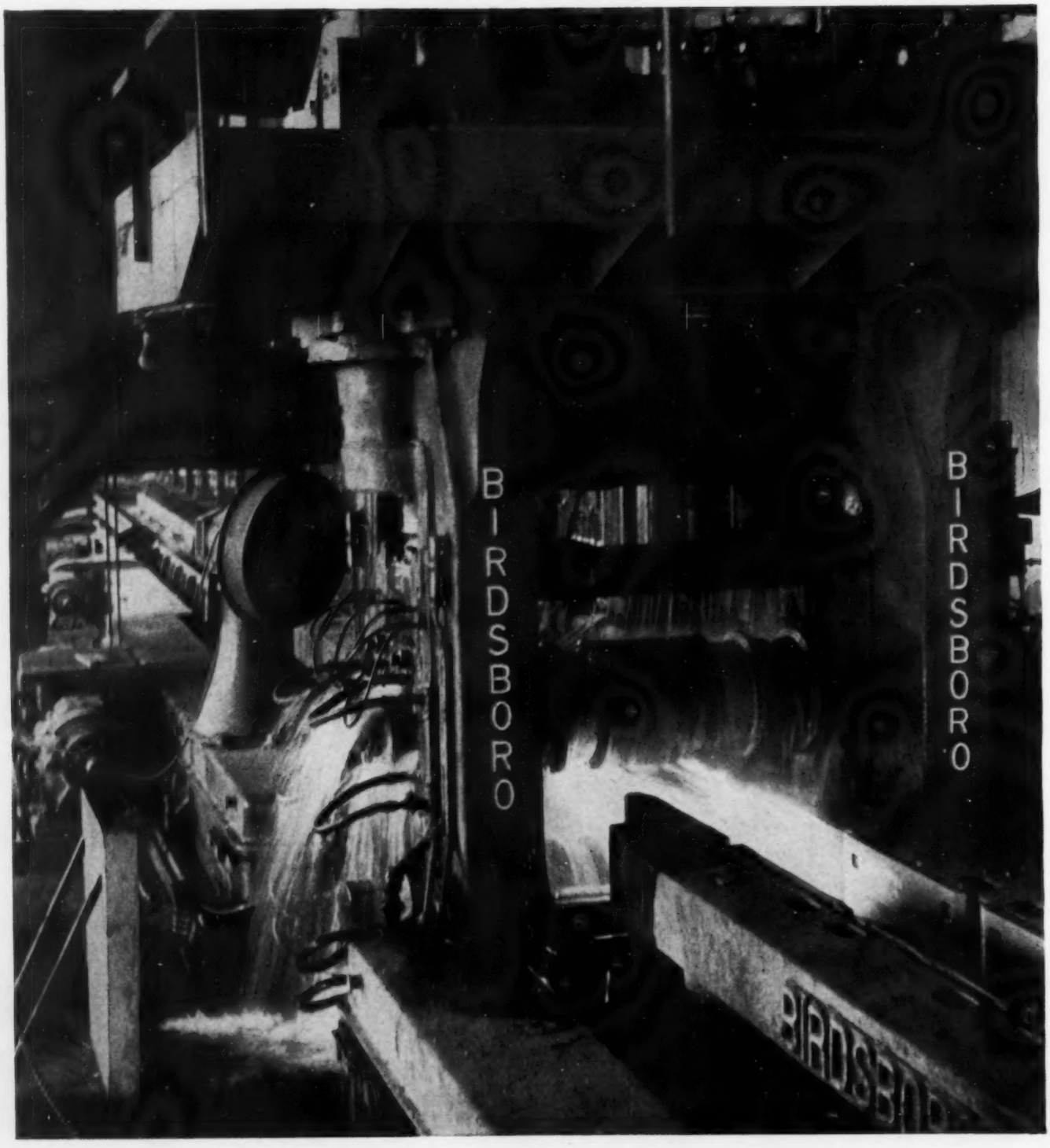
Allis-Chalmers has designed and built high speed rotating machinery for over 50 years. Its facilities are among the finest in industry. A-C centrifugal blowers are now being used extensively in iron and steel, as well as in many other industries. Perhaps this experience may help you solve your particular gas handling problems. A qualified A-C representative will be glad to talk it over with you. ALLIS-CHALMERS, MILWAUKEE 1, WIS. A 2385

Regulex and Texrope are Allis-Chalmers trademarks.

ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment—Biggest of All in Range of Industrial Products

SPEED UP
Mass Production

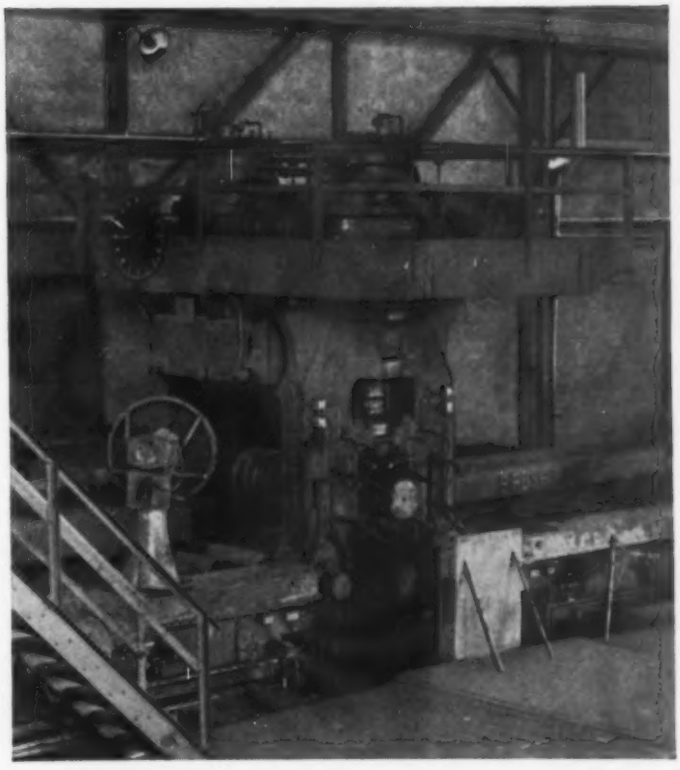


# of Steel with BIRDSBORO BLOOMING MILLS

PROBLEM ➡ Mass production of high quality stainless, high speed, automobile and special purpose alloy steels with minimum labor costs.

SOLUTION

This 2-high, rapid reversing 26-in. blooming mill with fast screw-down and rapid manipulation, operated by two men.



Birdsboro's engineering facilities make possible the design and construction of "custom-built" blooming mills which, today, are helping many manufacturers catch up with the demand for all types of durable goods.

Let our engineers go to work with yours in the planning stage and in this way, come up with a practical solution that will speed production as well as hold down operating and maintenance costs.

BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY • BIRDSBORO, PA.

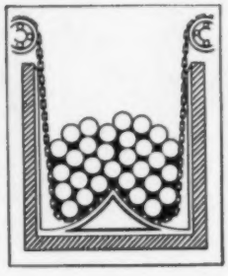
BUILDERS OF: Steel Mill Equipment • Rolls • Hydraulic Presses • Special Machinery • Crushing Machinery • Steel Castings

BES 2-47

BIRDSBORO

STEEL MILL EQUIPMENT

A "Sweet" Pickler



MONEL CHAINS *in the Weldco mechanical pickler move up and down alternately, revolving stock and exposing all surfaces. At left, Monel "spreader" which helps revolve load, crack oxide scale and increase agitation. Sprockets, chain, and tank trim are also Monel.* (*Fabricated by* Youngstown Welding & Engineering Company, Youngstown, O.)

● You've seen mechanical picklers before.

But have you come across one with all the features of this *Weldco* job?

Developed by the YOUNGSTOWN WELDING AND ENGINEERING COMPANY, Youngstown, Ohio, it handles everything from bars, flats and tubes to rounds, squares and hexagons. Automatically raises and lowers up to 10-ton loads at whatever speed you set. Cuts pickling time as much as 40 to 60 per cent.

Yet that's only the beginning. The *Weldco* mechanical pickler saves steam, acid, labor and maintenance besides.

Take the "spreader," a device that breaks up the load and makes it roll. This not only increases agitation, but also helps crack oxide scale. You get *faster* pickling . . . uniform action on *all* surfaces . . . reduce over-pickling . . . save steel.

The spreader — like all exposed parts of Youngstown's Weldco mechanical pickler — is made of Monel*. Experienced pickling room men know the *additional* savings that Monel makes possible.

For Monel withstands attack by hot sulfuric acid and other pickling solutions in common use by steel mills. It retains its high strength and resistance to corrosion. It assures more continuous operation . . . requires less time out for repairs.

You get these advantages, too, when you specify Monel for crates, racks, baskets, hooks, chain and accessories. Whether you measure loads in pounds or tons . . . whether you pickle sheets, tubes or castings, tiny screw machine products or heavy stampings . . . *Monel is the practical, economical metal for the job.*

Monel*

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK 5, N. Y.

NICKEL (INCO TRADE MARK) ALLOYS

MONEL* • "K"* MONEL • "S"* MONEL • "R"* MONEL • NICKEL • "KR"* MONEL
INCONEL* • "Z"* NICKEL • "L"* NICKEL

*Reg. U. S. Pat. Off.

ONLY PERFECTLY-CENTERED CONDUCTORS GIVE *Longest-Lived* CABLES

. . . and Okonite's Strip Insulating Method assures perfect centering

The Okonite Strip Insulating Method is the only process that provides perfect centering of conductors and at the same time permits inspection of every foot of insulation during the entire application operation.

Here's what happens. Precisely-measured, smoothly-calendered strips of rubber compound pass through "covering wheels" and are individually folded around the conductor.

This procedure provides automatic centering. It eliminates uneven walls of insulation. And as a result, the Okonite Strip Method removes every chance of electrical failure from imperfect centering. The process is the same for all layers, except that the outside layer is backed with a pure tin sheet, forming a continuous metal mold to assure uniform vulcanizing.

Bulletin 101 gives you further information on the Up-River Fine Para rubber used in Okonite insulation as well as data on many manufacturing steps taken only by Okonite to build user-benefits into longest-lived electrical wires and cables. Write for it to The Okonite Company, Passaic, New Jersey.

with today's installation costs only the

Longest-Lived

will be economical

* The lifetime cost of a cable rather than its first cost is the only true measure. Okonite wires and cables, built to stand up better and longer, can offset high installation costs.

6508

OKONITE SINCE 1878 **insulated wires and cables**

THE BEST CABLE IS YOUR BEST POLICY

Q. what is the correct brush pressure?

A- *See Speer!*

Too much depends on type of brush and brush holder and on the condition and speed of the commutator to make iron-clad rules for the best brush pressure. The only way of determining *exactly* the most economical and efficient ratio is by actual test.

Speer Carbon Company engineers are equipped to make such tests for you. Out of their years of experience in the manufacture and application of brushes, they'll give you a recommendation for the most efficient spring pressure—and at the same time, recommend proper brushes for all-around, better performance.

Whenever it's a question of brushes, take advantage of our research and experience. Call in a Speer engineer.

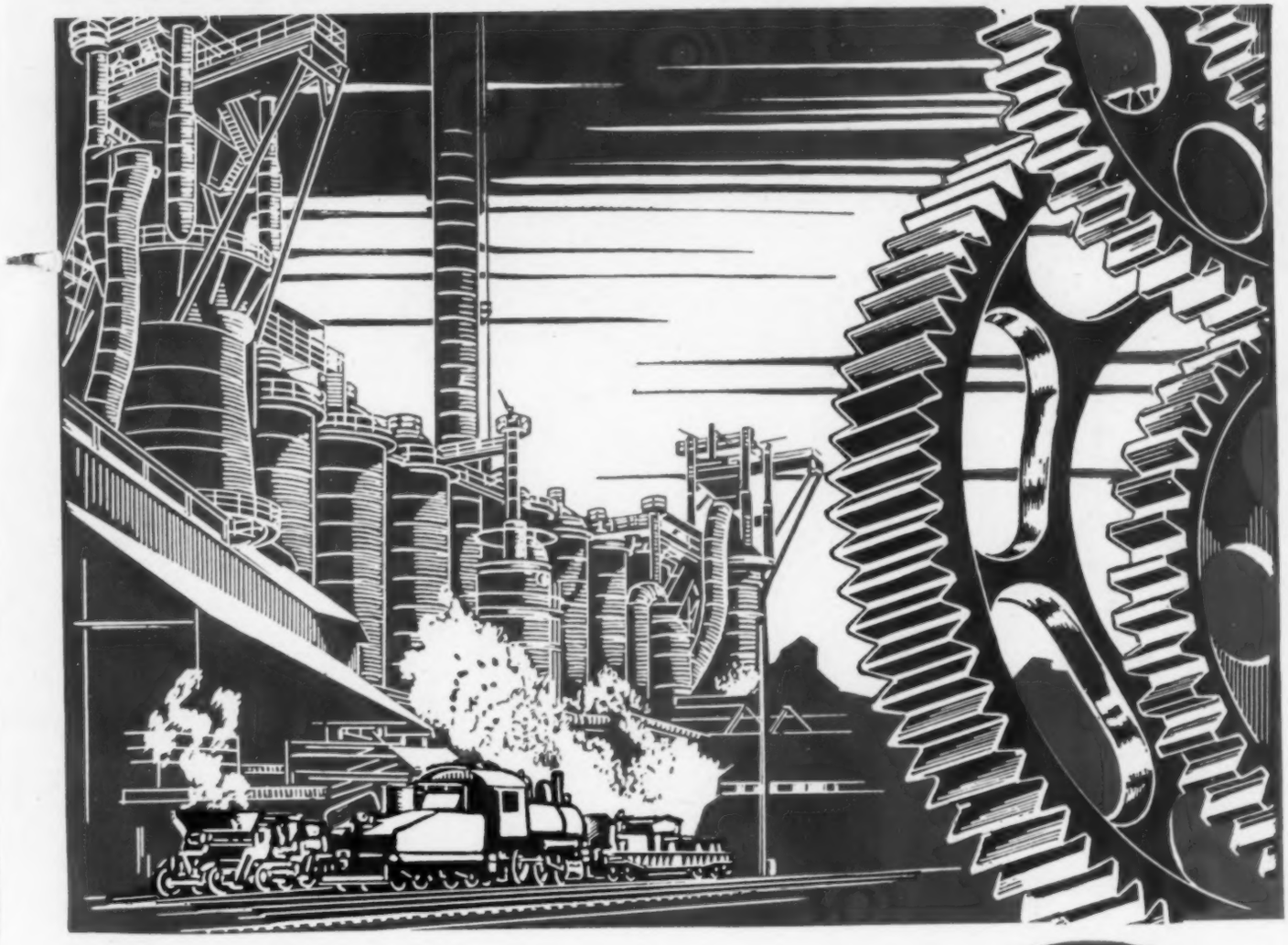
Speer

CARBON COMPANY
ST. MARYS, PENNA.

brushes • contacts • welding electrodes • graphite anodes • rheostat discs • packing rings • carbon parts

CHICAGO • CLEVELAND • DETROIT • MILWAUKEE • NEW YORK • PITTSBURGH

YES! Tycol "Engineered Lubrication" performs better . . . BETTER . . . BETTER



Tycol Engineered Lubrication performs better because:

. . . *Tycol Engineered Lubrication* is scientifically engineered to meet every service condition in modern industry, no matter how extreme or unusual.

. . . *Tycol Engineered Lubrication* helps you "get it done" faster and more efficiently . . . production jumps when you switch to a Tycol oil or grease.

. . . *Tycol Engineered Lubrication* means new economies for you . . . by cutting repair bills, and lengthening equipment life.

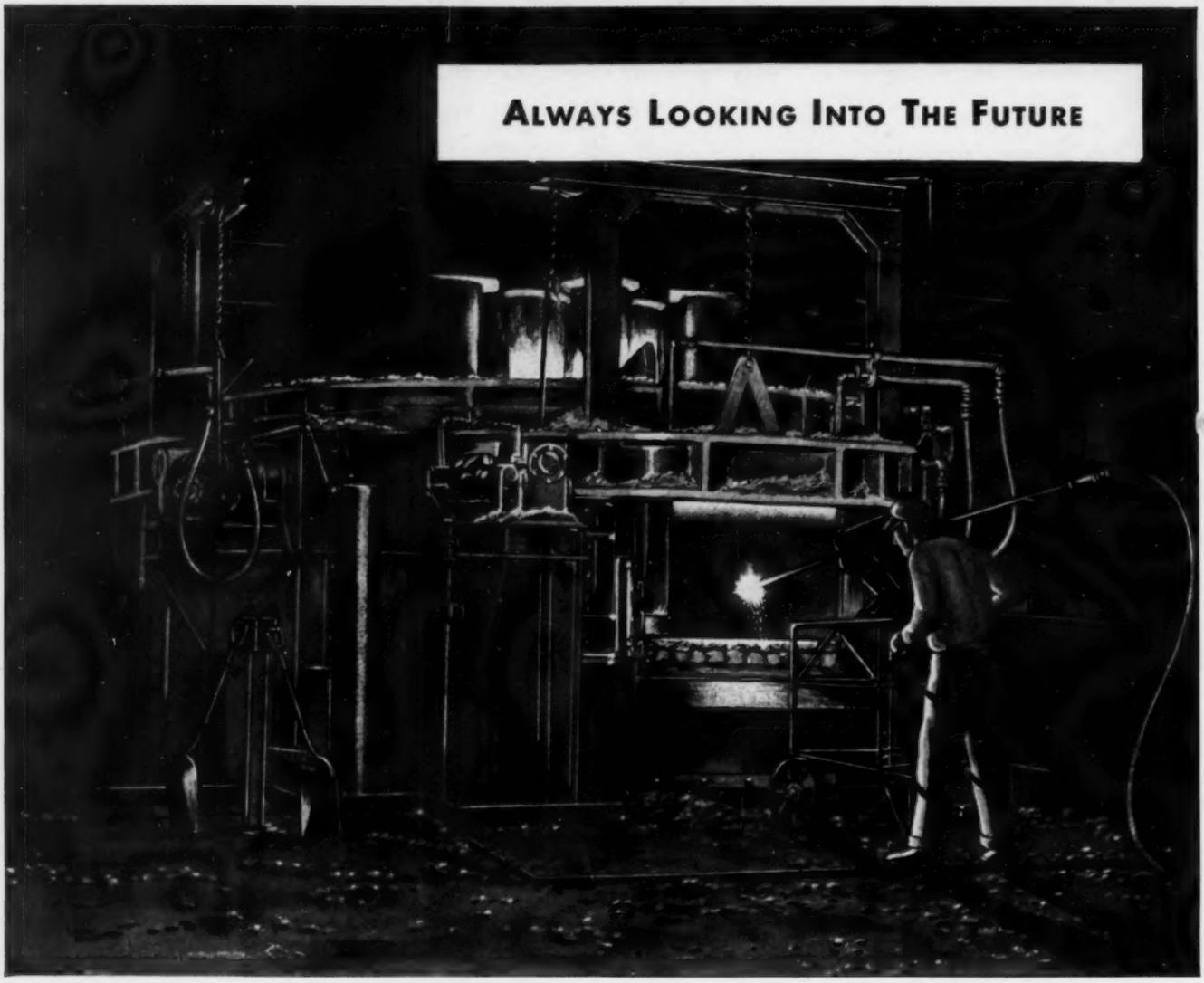
Let Tide Water Associated help you select the best lubricant for your particular need. Write, wire or phone today to your nearest Tide Water Associated Office.

TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C.
Pittsburgh • Philadelphia
Chicago • Detroit • Tulsa
Cleveland • San Francisco

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE - NEW YORK 4, N.Y.

LUBRICATION — "ENGINEERED TO FIT THE JOB"



Airco makes possible new advances in electric furnace steel production

Air Reduction's continuing research and development program for new uses of oxygen for the steel industry has brought forth a promise of new benefits for electric furnace steelmaking methods.

At present, this metallurgical use of oxygen falls into three fields: (1) as an aid to scrap melting, (2) as a means of controlling bath temperature, and (3) to accelerate decarburization.

This new use of oxygen offers steel men many advantages over former electric furnace production methods. Power savings on oxygen treated heats are as much as 20%. Carbons in the 0.025 to 0.05 per cent ranges are easily obtained. Furnace refractories are in better condition because they are held at high temperatures for shorter periods.

Research on this use of oxygen is only one phase of the Air Reduction program. This same forward thinking is at work in the further development of these oxygen processes, and also in the perfection of metallurgical uses of other industrial gases for flushing, desiliconization, desulphurization, and similar related processes.

• • • •

If you would like more data on oxygen in electric furnace steelmaking, as well as data on other new processes as they are developed, write us immediately. We will place your name on a list to receive all releases as they are issued. Address Dept. IS 8518, Air Reduction, 60 East 42nd Street, New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, Houston 1, Texas. On West Coast: Air Reduction Pacific Company, San Francisco 4, Calif.

AIRCO **AIR REDUCTION**

Offices in All Principal Cities

Headquarters for Oxygen, Acetylene and other gases ... Carbide ... Gas Welding and Cutting Machines, Apparatus and Supplies ... Arc Welders, Electrodes and Accessories

UNITED

42"—4 High, 5 Stand COLD STRIP Mill capable of rolling tin plate at speeds up to 5000 feet per minute.

A Product of

UNITED ENGINEERING AND FOUNDRY COMPANY

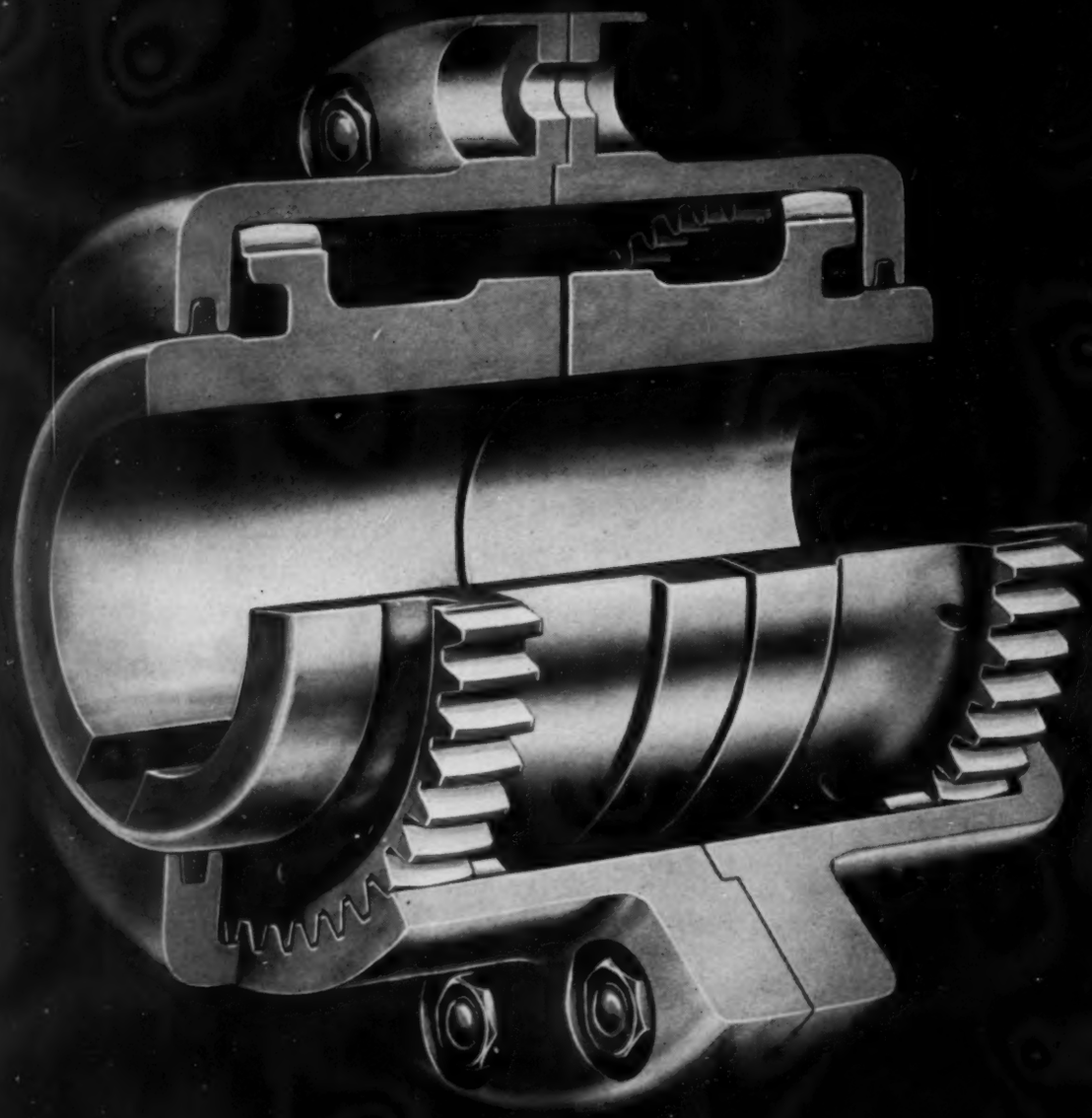
PITTSBURGH, PENNSYLVANIA

Plants at PITTSBURGH • VANDERGRIFT • NEW CASTLE
YOUNGSTOWN • CANTON

Subsidiary: Adamson United Company, Akron, Ohio

Affiliates:

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

PRODUCT *Information*

ON ANY OF THE PRODUCTS MENTIONED IN THIS ISSUE

Below is an index of products referred to in editorial and advertising pages of this issue. If you desire additional information on any of them, use one of the accompanying postcards in requesting it. In each case give name of product and page number. The information will come to you directly from the manufacturer involved.

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IRON AND STEEL ENGINEER May, 1948

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Name .....

Title or Position .....

Company .....

Address ..... City ..... Zone .... State .....

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No Postage Stamp Necessary If Mailed in the United States

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First Class Permit No. 1963, Sec. 510, P. L. & R. Pittsburgh, Pa.

IRON AND STEEL ENGINEER

1010 EMPIRE BUILDING

PITTSBURGH 22, PA.

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IRON AND STEEL ENGINEER May, 1948

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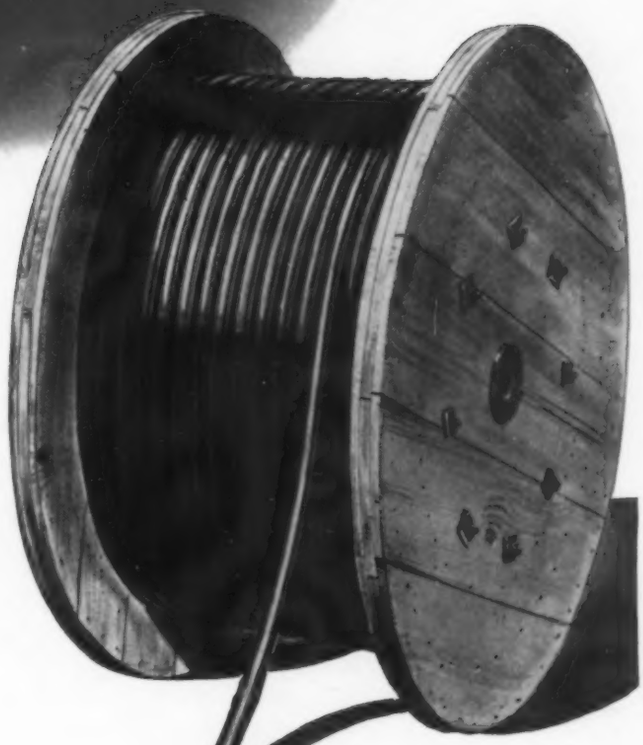
IRON AND STEEL ENGINEER

1010 EMPIRE BUILDING

PITTSBURGH 22, PA.

SOLDER ALUMINUM...



Use standard methods with ALCOA Solder and Flux

Use the same standard methods! Solder aluminum to aluminum, or aluminum to copper, with torch, ladle, or soldering iron. Soldering a wire or cable made with Alcoa E.C.* Aluminum Conductor presents no problems.

For best results, use Alcoa Soldering Flux and Alcoa Solder.

Easier handling and easier pulling, with no problems of joints and terminals, mean big savings in installation costs. And the lower cable costs mean even bigger savings.

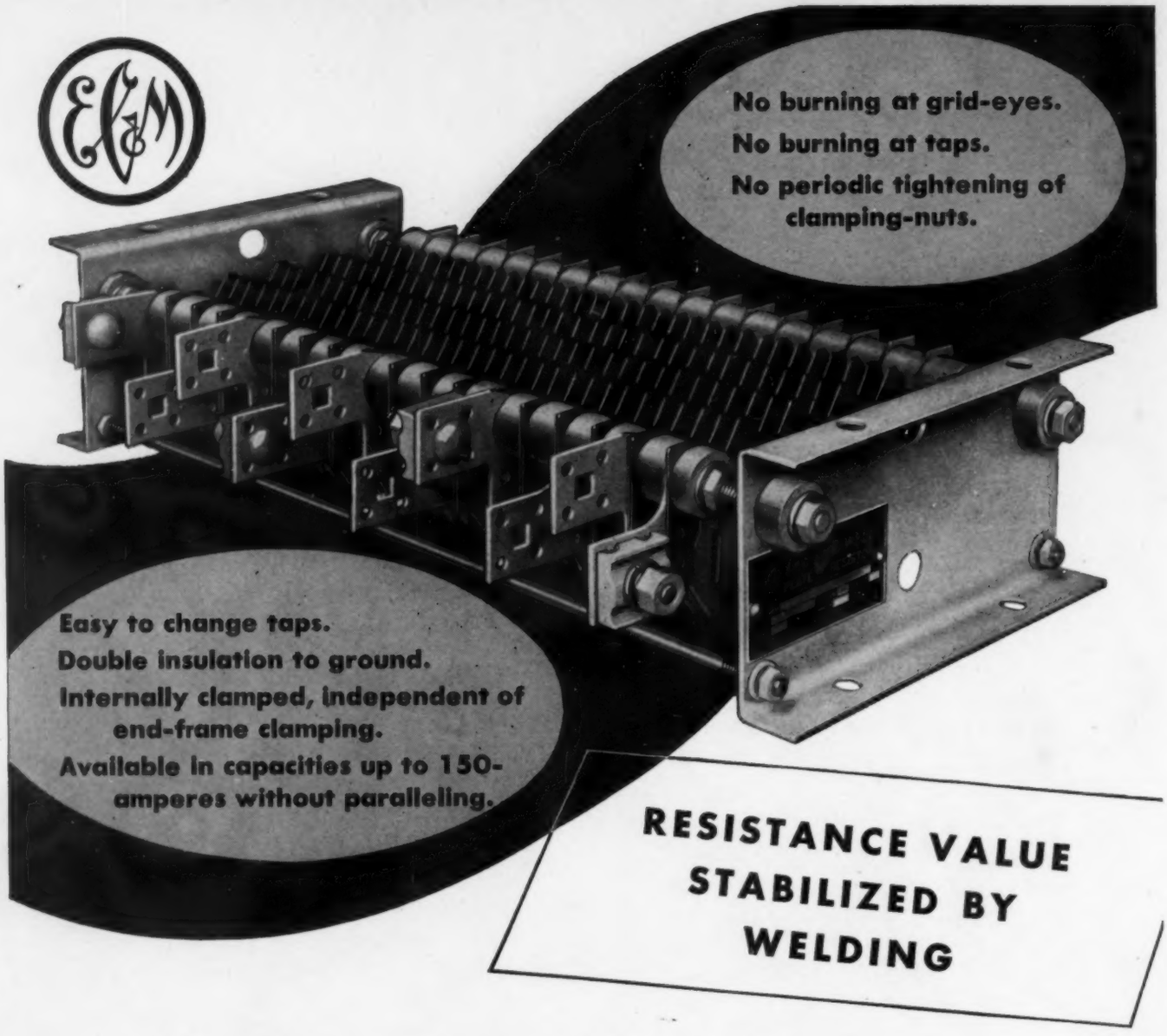
Alcoa makes light, strong, conductive E.C. Aluminum; leading wire and cable manufacturers draw, strand, insulate, and sell it under their own trade-marks. Your wire supplier can furnish information on sizes and types of insulation. ALUMINUM COMPANY OF AMERICA, 2128 Gulf Building, Pittsburgh 19, Pennsylvania.

The BIG DIFFERENCE is in your COSTS!

*E. C.: *Electrical Conductor* Aluminum

ALCOA EC ALUMINUM

FOR ELECTRIC WIRE AND CABLE


No burning at grid-eyes.
No burning at taps.
No periodic tightening of clamping-nuts.
Easy to change taps.
Double insulation to ground.
Internally clamped, independent of end-frame clamping.
Available in capacities up to 150-amperes without paralleling.

RESISTANCE VALUE STABILIZED BY WELDING

Regular maintenance programs call for periodic inspection of all operating equipment, including the resistors. Due to the need for keeping production going, only a hurried examination can, at best, be employed. The clamping-nuts may be tightened, but the original resistance value is not restored if the grid-eyes have been burned while operating under loose pressure. *You never have to worry about the resistance value of EC&M TAB-WELD Resistors.* Welding of mated resistor-ends insures high capacity contact between grids. Tap-plates, welded in position at frequent intervals, provide rigid terminals for attaching external leads. For lower maintenance costs, use EC&M TAB-WELD Resistors.

TRADE MARK
TAB PLATE WELD RESISTOR
PATENT NO. 2,378,058

SPECIFY EC&M Bulletin 942
TAB-WELD Resistors.

THE ELECTRIC CONTROLLER & MFG. CO.

2698 East 79th Street • Cleveland 4, Ohio

In the CONSTRUCTION of the 11 U. S. and CANADIAN CONTINUOUS BUTTWELD PIPE MILLS...*

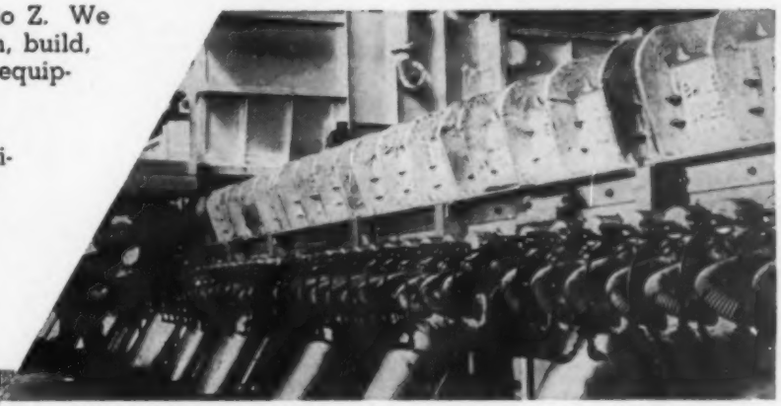
SALEM HAS SERVED AS ENGINEER, BUILDER OR SUPPLIER OF EQUIPMENT ON ALL 11

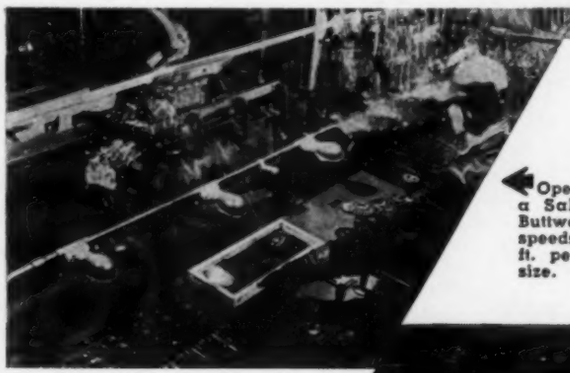
SALEM KNOWS the pipe business requirements. It was our thorough understanding of this business that enabled us in 1938 to design and build the furnaces for the FIRST buttweld mill in the U. S. A., and the furnaces used on all succeeding buttweld mills.

SALEM DOES the whole job from A to Z. We study your specific problems and design, build, and through experienced operators, set equipment in operation.

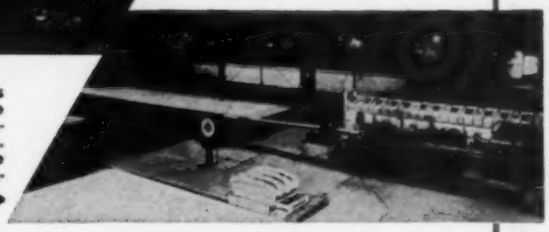
SALEM WILL send an experienced engineer to survey and discuss your needs, and will prepare a detailed proposal and layout. Write or phone today for complete information on Salem Furnaces for buttweld mills.

This Salem furnace heats cold skelp to 2400° F. in 21 seconds! Salem is the only company which has built a furnace for continuous buttweld pipe mills. All of these proved successful from first day of operation.





Operator's pulpit on a Salem Continuous Buttweld Pipe Mill . . . speeds as fast as 550 ft. per minute in ½" size.



The original single loop has been improved by a double loop. Saves space and improves operating efficiency. The patented Salem double loop eliminates time-consuming difficulties.

*HERE'S THE LIST SO FAR

ETNA, PENNSYLVANIA . . . Two furnaces by Salem
WELLAND, ONTARIO . . . Complete installation by Salem
YOUNGSTOWN, OHIO . . . Complete installation by Salem
YOUNGSTOWN, OHIO . . . Furnace by Salem
YOUNGSTOWN, OHIO . . . Furnace by Salem
SPARROWS PT. . . . Two complete installations by Salem
INDIANA HARBOR . . . Complete equipment by Salem
BENWOOD . . . Complete installation and equipment by Salem
FONTANA, CALIFORNIA . . . Furnace by Salem

B-W

Salem Engineering Company

HEADQUARTERS FOR HEAT TREATING DESIGN

Salem, Ohio *Southwest Office, Fort Worth, Texas*

SALEM ENGINEERING (CANADA) LTD., TORONTO, ONT.
SALEM ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND

Now...INTERNATIONAL OFFERS YOU A NEW COST CUTTING ADVANTAGE

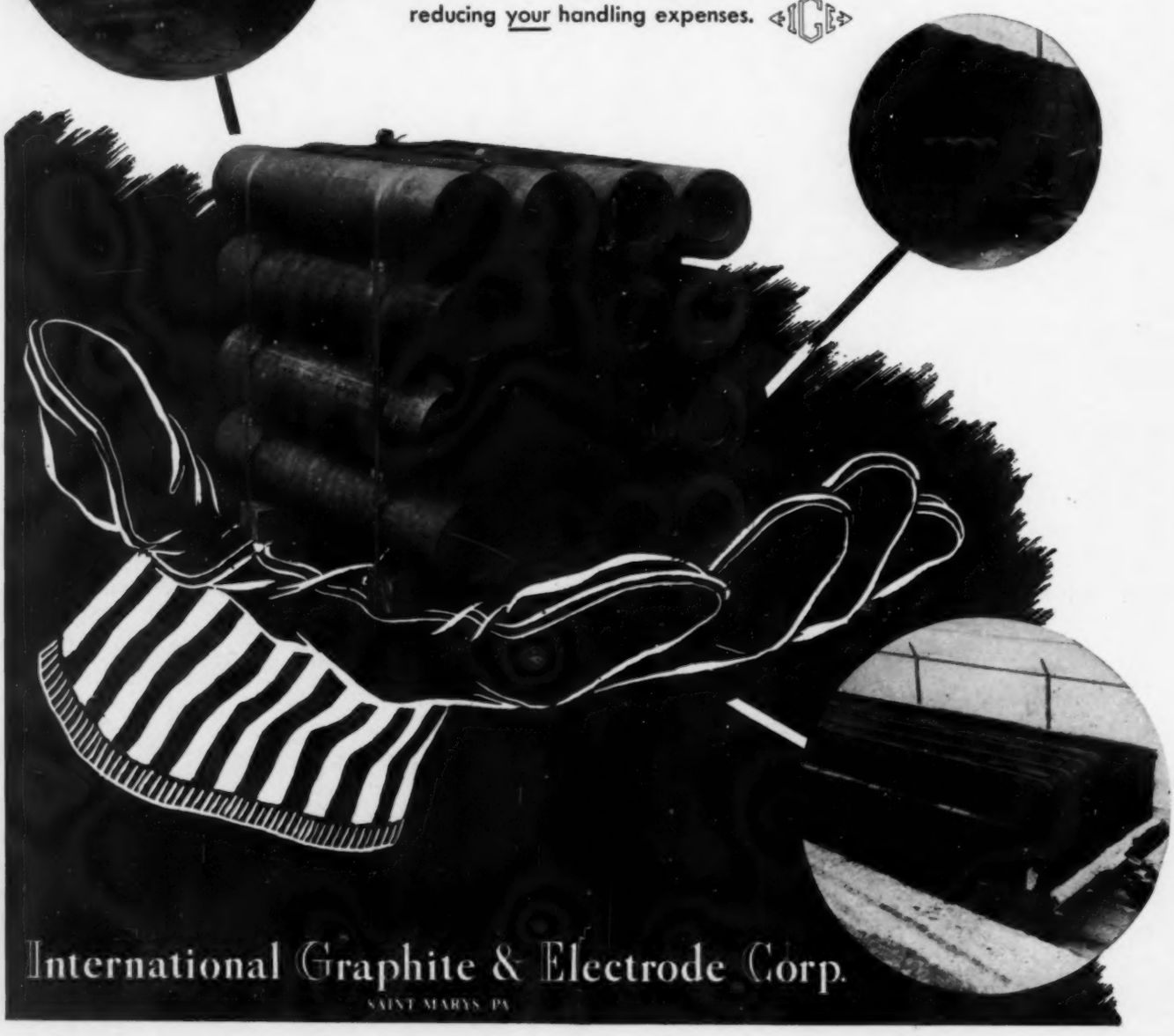
International's new method of shipping electrodes may reduce handling costs 90% or more.

Electrodes in sizes up to 14" x 60" are shipped as a bundle, held together by steel straps. In a matter of minutes these bundles are removed as units from boxcars and gondolas by crane or fork lift truck.

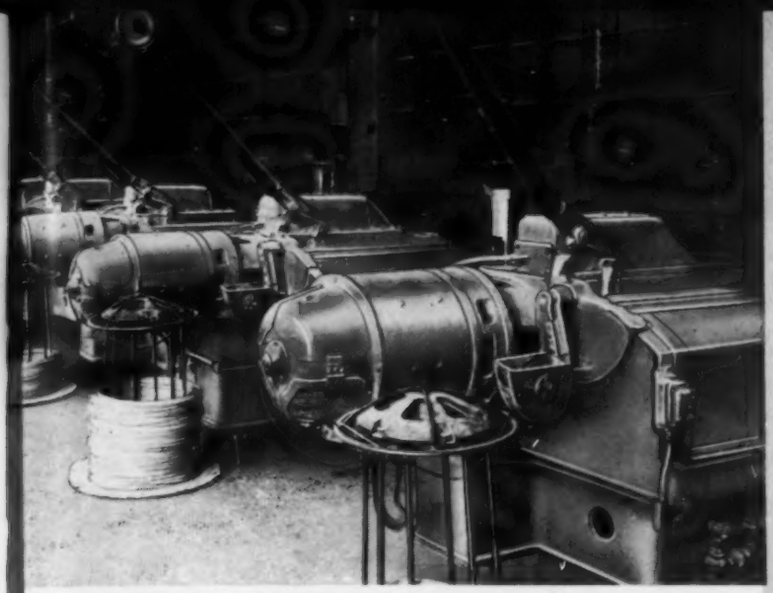
One user of International Graphite Electrodes, shipped this new way, reported unloading time reduced from 10 hours to 50 minutes! At another plant, reduced handling time resulted in a saving of almost $200.00 in one shipment.

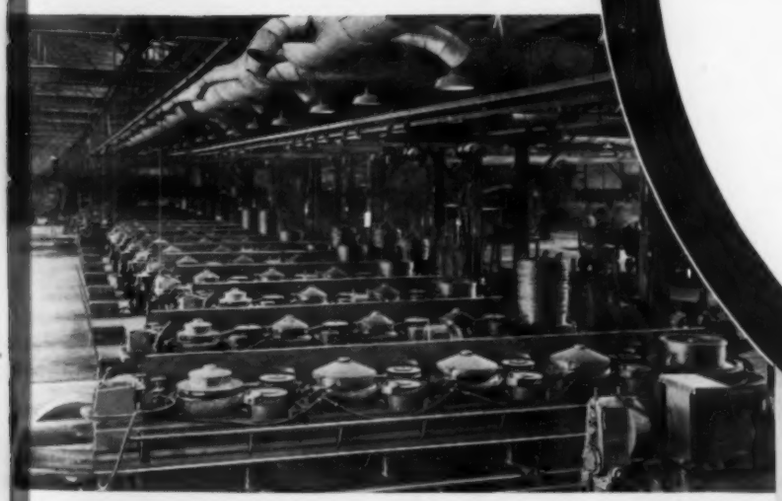
This improved method of shipping electrodes eliminates the use of blocks and crowbars — prime causes of chipping and breakage during unloading.

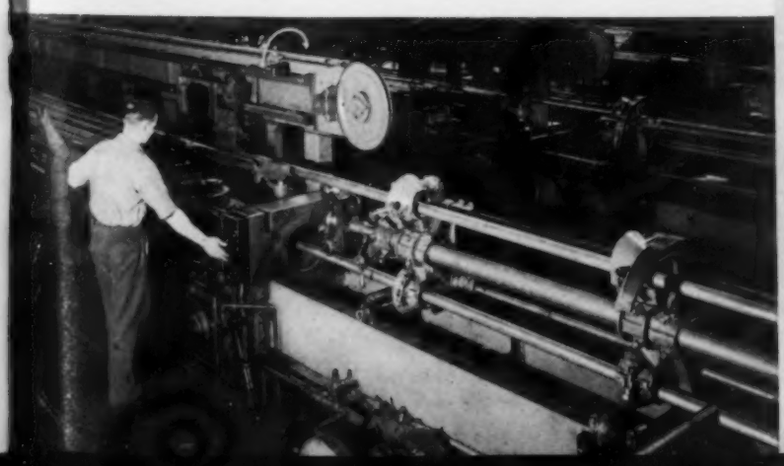
Write today for information on how International can help you cut overall electrode costs, by reducing your handling expenses.



International Graphite & Electrode Corp.
SAINT MARYS PA







Here's Cold Precision

for your most varied production requirements!

Vaughn

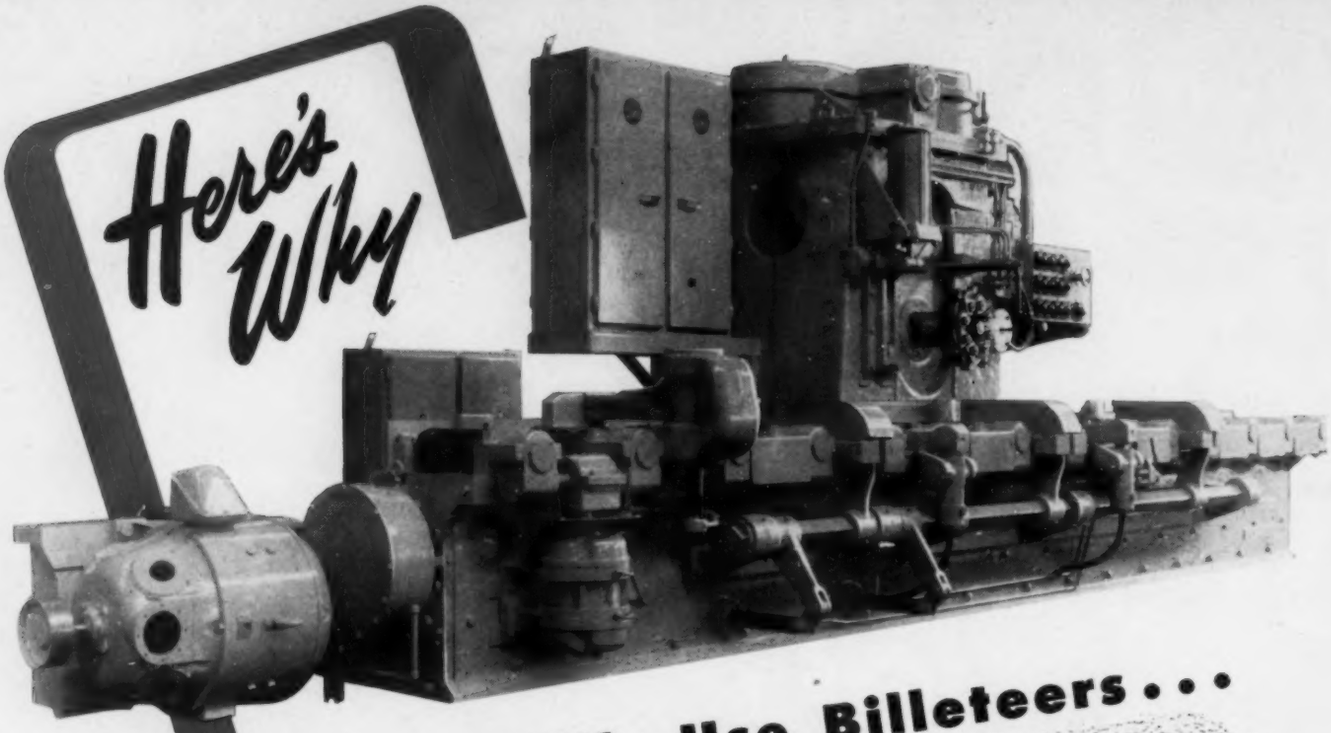
Cold Drawing Machinery

Vaughn's relentless precision in engineering and manufacture assures unfailing machine dependability under your most exacting production schedules. *We'll be glad to detail the facts!*

THE VAUGHN MACHINERY COMPANY
CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

VAUGHN MACHINERY
Profitably Used by Leading
Producers Since 1871
"QUICK ON THE DRAW"



Here's Why

Leading Steel Mills Use Billeteers . . .

HIGH-SPEED PRODUCTION with efficient use of manpower is a feature of the Bonnot Billeteer. One Billeteer releases 10 to 20 men each turn for more profitable jobs.

BILLETEER OPERATION, with finger-tip control, is easily learned. Through fast precision controls, one man manages loading, chucking, cutting, turning and unloading. The 45-ton machine takes all the punishment.

OVERALL SAVINGS where properly used can be conservatively estimated at 50 per cent.

VALUABLE BILLETS are saved from expensive remelting operations. The Billeteer speedily removes flaws normally too bad for reconditioning.

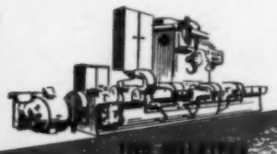
SCRAP CHIPS of known analysis are saved by the Billeteer at the rate of about 1½ tons per machine per day.

SHIFT AFTER SHIFT the rugged machine operates dependably, producing clean billets ready for rolling on schedule.

SAFETY DESIGN of the Bonnot Billeteer has brought a new standard of safety to billet-sheds.

LOW MAINTENANCE COSTS are a result of good engineering design, rugged construction and generous tolerances for overloads.

Bonnot engineers will be pleased to give you further information about this machine. Write today!



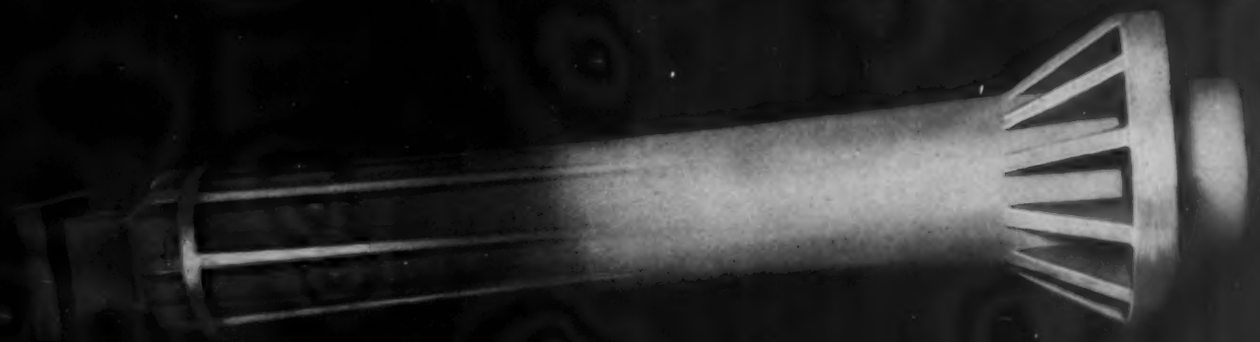
The Bonnot Co.

Engineered For Improved Production

STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

ALSO MANUFACTURERS OF SAWING · CRUSHING · PULVERIZING & MIXING EQUIPMENT

UNION PEELS STAND UP



UNDER THAT CONTINUOUS "ORDEAL BY FIRE"

Shown above are standard and special fluted peels, furnished either as rough castings or fully machined ready for installation. Double Life Head Charging Boxes are cast in ordinary carbon steel or "UNIVAN"—a nickel-vanadium alloy of exceptional shock-absorbing, heat-resisting qualities.

Except for the charge itself, no piece of unprotected metal is subjected to greater heat for a longer time than the peel. And, hot or cold, it must withstand severe shock and stresses as well. "Union" has developed for this tough service peels of heat and shock resistant alloys in designs that add months to their useful life . . . Glad to quote from your specifications.

UNION *Double Life Head* CHARGING BOXES

The hot-and-cold life of a charging box has been greatly extended by Union designers, engineers and metallurgists. The antiquated open type head has been replaced by an improved reinforced head which eliminates cracks and distortion . . . Whether you operate with 20, 25, 36 or even 50 cu. ft. capacity, we welcome the opportunity to prove that you can do a faster charging job for less cost with Union "Univan" Charging Boxes.

"UNIVAN"

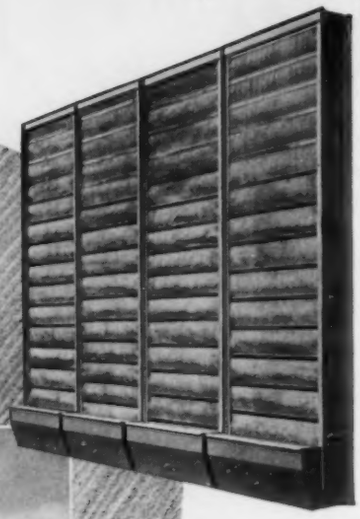
UNION STEEL CASTINGS

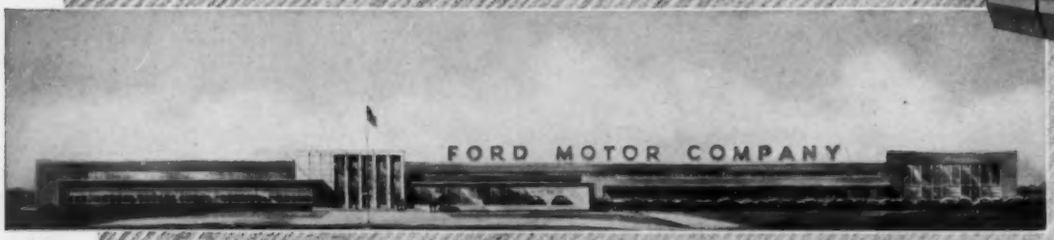
DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.

Cinder Pots • Slag Pots • Coupling Boxes • Spindles • Gears • Bells and Hoppers • Ingot Cars • Charging Cars • Annealing Boxes and Bases

IS THERE A STAYNEW IN *YOUR* FUTURE?

FORD MOTOR COMPANY SELECTS STAYNEW AUTOMATIC AIR FILTERS FOR TWO NEW PLANTS





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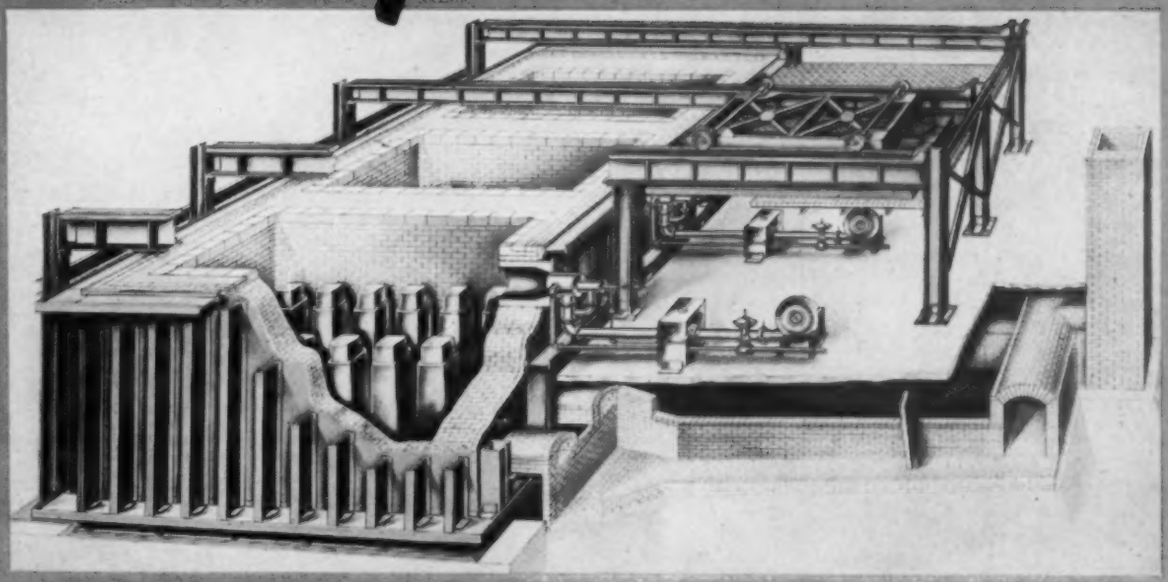

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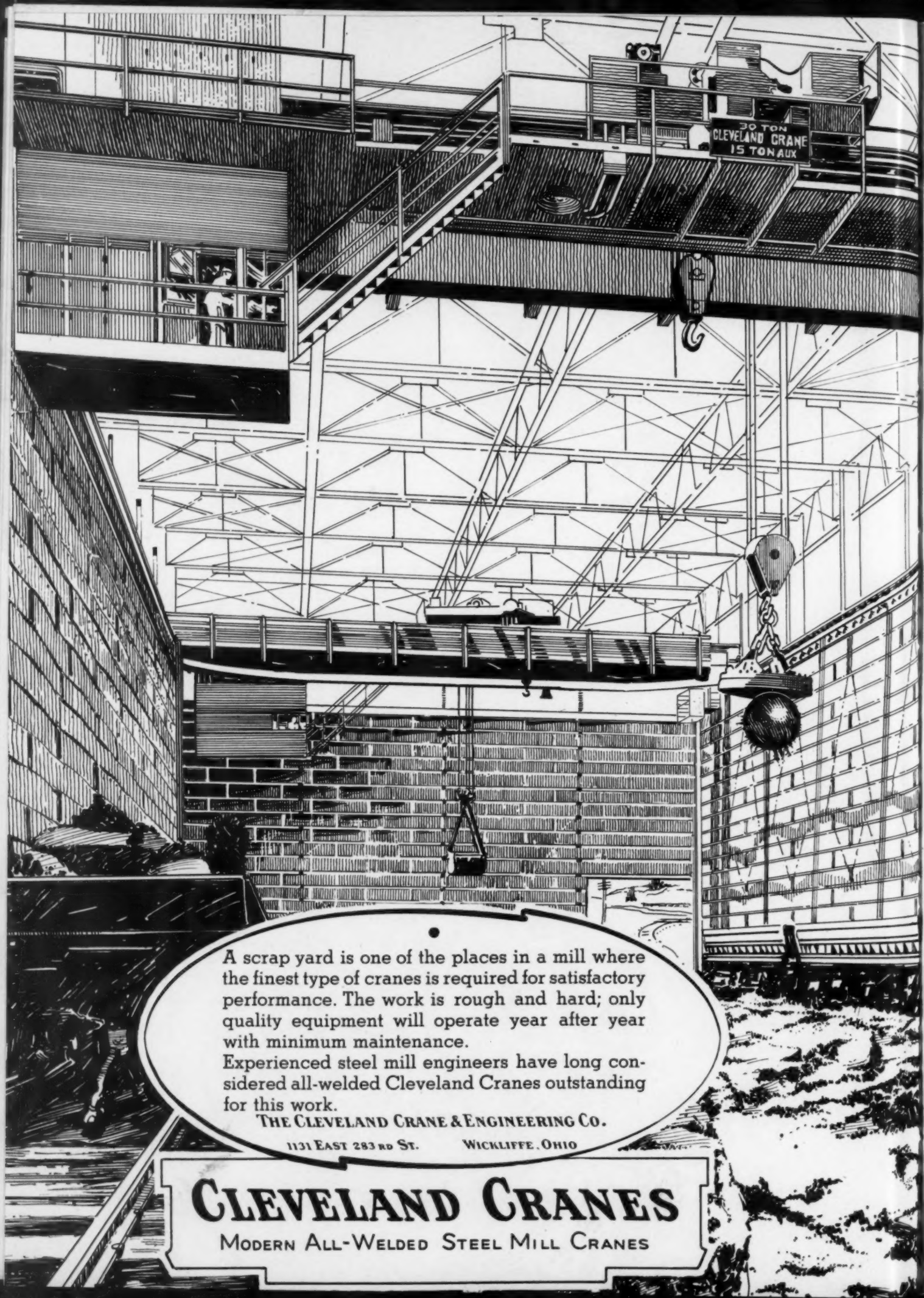

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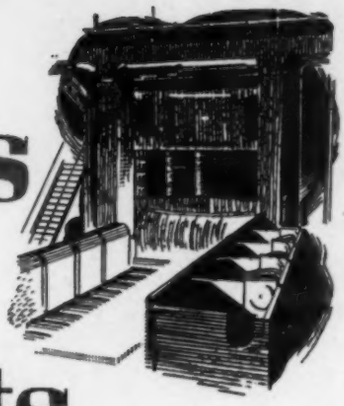

REPUBLIC Steel Corporation's Cleveland plant is the scene of experimental work using radioactive sulphur to trace sulphur through steelmaking processes. By introducing the radioactive sulphur into the various materials going into a process and then measuring the radioactivity in the product, the behavior of that element may be learned. Already completed are tests that show that pyritic sulphur and organic sulphur in coal are carried over into coke equally. More tests are planned to trace sulphur in other materials and chemical combinations.

▲

THE Better Business Bureau of Pittsburgh recently uncovered a racket in radio repair business whereby charges were made for work not done and parts not used. Maybe the radio men were jealous of the farmers getting paid for not raising stuff.

One consolation amid all the rackets and inflated prices is the fact that it still costs only $15 to have your car overhauled — by a motorcycle cop.

▲

A new table of British income taxes is such that, at $50,000 of net income from investments, the tax will be more than the income. The actual amount of money left from investment income after taxes reach a maximum of $6600 at a net income of $15,000. Above $15,000, the investor has less and less actual money left, and above $50,000, the investor will actually be forced to sell holdings to pay his taxes. Such confiscatory taxes can be nothing but a further hindrance to the economic recovery of Britain.

▲

WHAT with its corner on all the political conventions this year, Philadelphia is in fair shape to challenge Chicago's title of "the windy city."

▲

THE Eisenhower boom is a fine example of the value of keeping one's mouth shut. Every war is followed by a wave of sentiment for the commanding generals, and every war except World War I was followed by an ex-military president. Even though his record is not free from errors, few will dispute that Ike was an able general. There is nothing, however, to indicate that he would make a good president. By keeping mum and not stating his position, he has kept from antagonizing various segments of voters, so that his popularity is running at high tide.

▲

AND speaking of political conventions, the latest suggestion we've seen for a slate is Eleanor Roosevelt for president and Walter Reuther for vice-president. We presume that is a Democratic ticket.

▲

AMONG resolutions to be considered by a certain union convention are demands for the right to elect their own foreman, a basic work week of 30 hours and abolition of overtime, under penalty of a fine. These points are typical of the thinking of some unions, which have gone beyond ignoring management's rights and now ignore the customer as well. The abolition of overtime is utter disregard of the customer, who already pays a penalty in overtime in order to obtain something he must have. Unions must remember that the livelihood of their members, as well as that of management, depends ultimately on the customer. Management puts forth effort to get and hold customers. Unions certainly should not work against these efforts.

▲

ONE of our traveling friends has defined civil service as what you get in hotels between wars.

▲

CHICAGO hotels must not yet have learned that the war is over. We have tried to schedule national meetings there, but are always faced with the demand that the people attending the meeting must arrive on Saturday and Sunday preceding the meeting. This, of course, means an extra day or two on a matter of 1000 rooms — in other words, a neat bonus of perhaps $8000 or $10,000.

Since we are unable to bring in our attendance that early, we have been unable to schedule a convention in Chicago. Other organizations have met the same problem, and resentment is growing. It's too bad. Chicago is a nice city and a fine convention spot — and we would like to go there again when conditions are righted.

▲

ACCORDING to some estimates quoted in Fortune, there is less than four weeks' supply of manganese in the United States.

▲

A FAVORITE motto says, "Do the difficult things now. The impossible things may take a little longer." This might well be the motto of blast furnace and open hearth men, who have learned to do many things that used to be called impossible. Necessity has forced them to use materials that would have been rejected as unfit for use 20 years ago. Yet today's products must meet more exacting standards than ever before, and in spite of it all, production and efficiency have increased. This, we believe is a result of the interchange of ideas fostered by the various technical groups, and even greater progress can be made through the cooperation of these groups. There should be no jealous bickering between them. Basically the object of all is the advancement of the industry, and no one group can do it alone. There is room for all.

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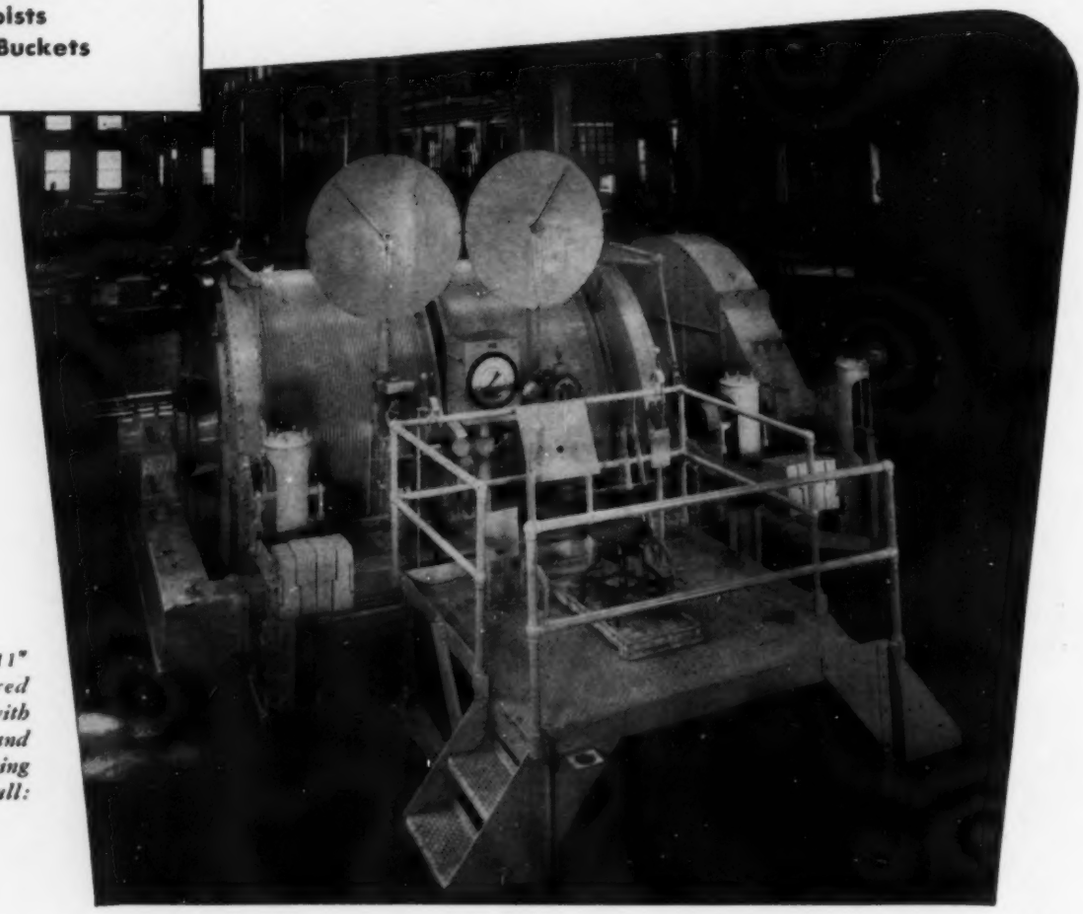

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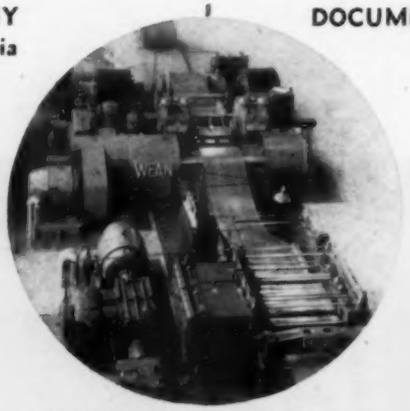

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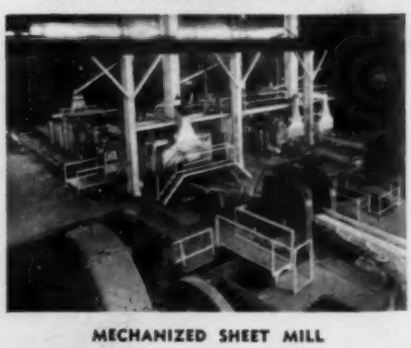

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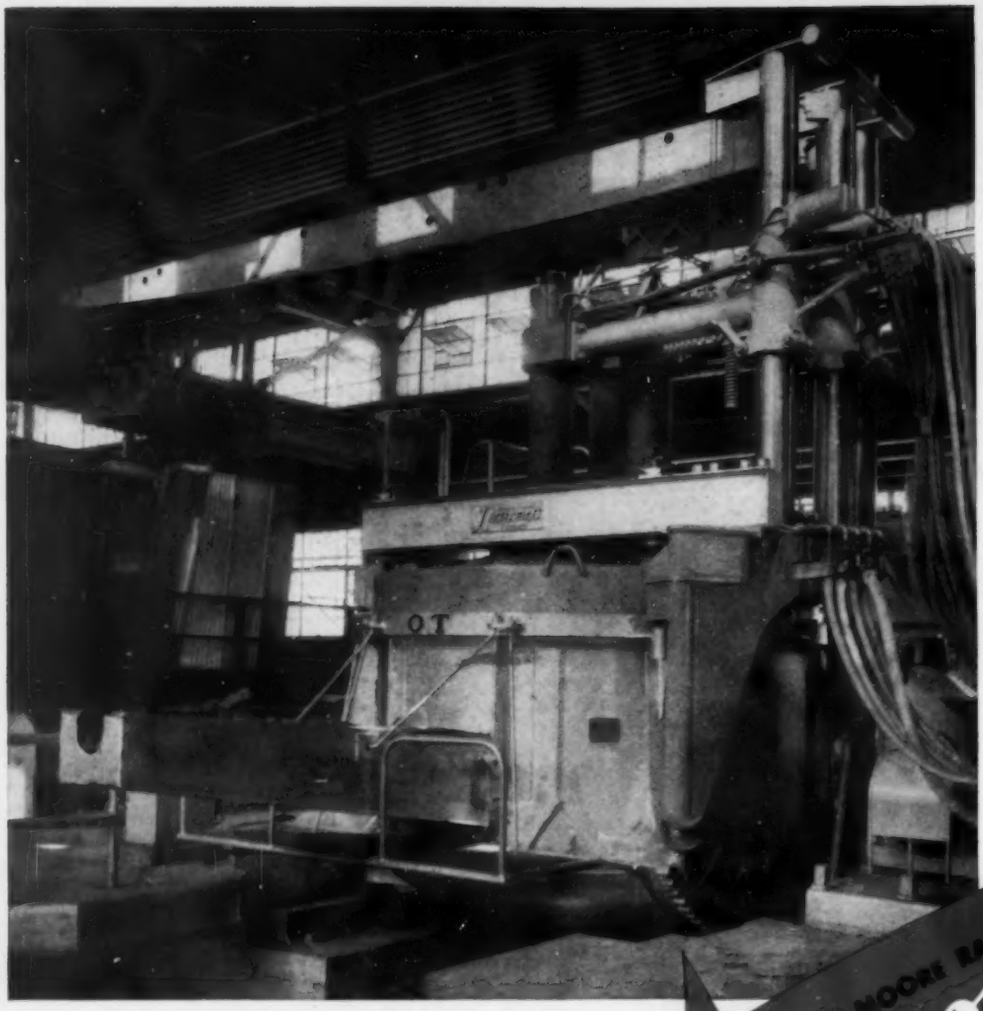

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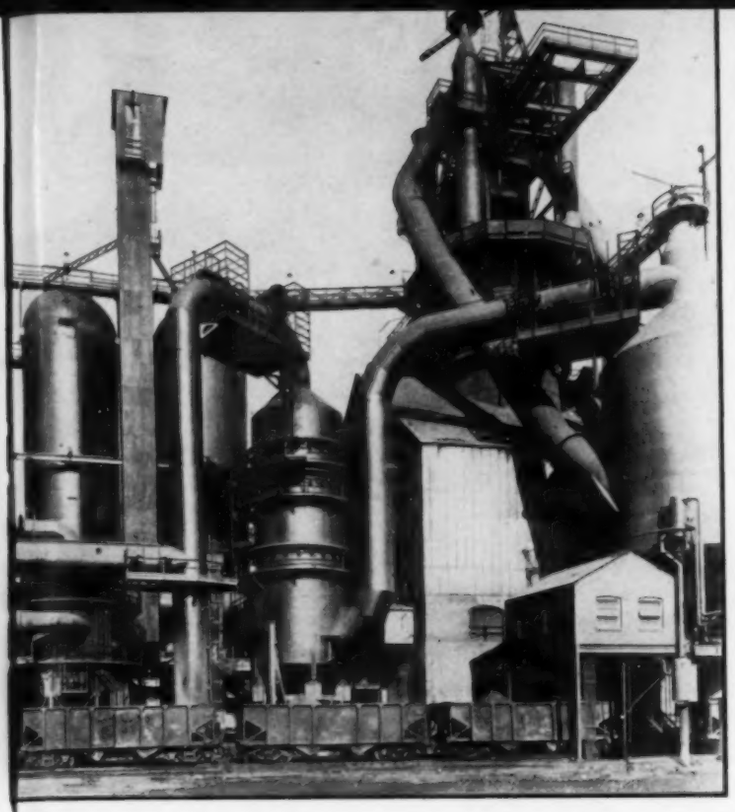


Progress in High Pressure Operations of Blast Furnaces

. . . . experience obtained from the operation of two blast furnaces under high top pressure has resulted in the development of a number of mechanical improvements which have reduced delays to a point equivalent to that on a normal pressure furnace . . . .

By B. S. OLD, E. L. PEPPER and E. R. POOR
Arthur D. Little, Inc.
Cambridge, Massachusetts

▲ THE first operation of a pig iron blast furnace using high top pressure, as proposed by Avery[1]*, was carried out by the Republic Steel Corporation under the auspices of the War Metallurgy Committee for the purpose of increasing blast furnace capacity during World War II. The experiment was carried out at the DPC No. 5 blast furnace operated by Republic in Cleveland, Ohio. The results obtained[2,3], in spite of mechanical difficulties encountered during the four-month run, showed sufficient tonnage increase to interest Republic in making further trials of their own after the war.

Republic's postwar trials were carried out on No. 5 furnace at Cleveland, which had a hard-surfaced bell and hopper installed, and the No. 3 furnace at Youngstown. The Youngstown furnace was relined and a new five-stage turboblower designed for pressure operation replaced the old blowing equipment.

The results of the trials at 10 psi top pressure were presented in detail by J. H. Slater[4] before the American Iron and Steel Institute. It has been found possible to increase iron production 11 to 20 per cent with a reduction in coke consumption of 13 per cent, reduce flue dust production 30 per cent or more, and effect a manufacturing cost saving of over $1.00 per ton of iron. With top pressures of the order of 20 psi possible with the new 125,000 cfm 40 psi gage turboblowers soon to be delivered, even greater tonnages and lower costs seem assured.

CONVERTING A PIG IRON BLAST FURNACE PLANT FOR HIGH TOP PRESSURE OPERATION

Although it is obvious that some of the engineering alterations involved in the conversion of a pig iron blast furnace and its plant to permit high top pressure operation will vary with different existing installations, there are many changes that will apply to any furnace and for convenience may be designated as standard engineering alterations. Regardless of detailed plant layout, these changes should be made before pressure operation is undertaken. In this paper, which will be largely a discussion of the so-called standard engineering alterations, the following assumptions are made:

1. The furnace and its plant are of conventional design and construction.
2. The operation of the charging system — i.e. skips,

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 25, 1947

*Numbers refer to bibliography at end of article.

bells, revolving distributor, etc., is effected by automatic sequence control.

3. A wet washer is included in the top gas cleaning system.

For clarity, each piece of equipment or part of the plant layout affected by high top pressure operation will be discussed under separate headings.

Blowing equipment — It has been found that many blast furnace plants have extra blower capacity during normal operations. This extra capacity can be utilized to its fullest extent with pressure operation without altering or replacing existing equipment. Even the plants which are operating their present blowers to capacity now can obtain benefits by using pressure operation at present wind volumes. The coke saving and decrease in flue dust production will still apply. However, maximum iron tonnages will result from blowing more wind, hence it is logical that greater blowing capacity is desirable in the long run. In some plants, where the blowing equipment is obsolete, inefficient and expensive to maintain, it will be advisable to purchase new blowing equipment, which, though high in cost will ordinarily pay for itself within two years through increased iron output.

The top gas under high top pressure conditions represents a potential source of power which might be used to operate a booster blower furnishing the additional wind and pressure desired. This power would be derived by expanding the hot top gases through a gas turbine, the exhausting gases still retaining their heating value, leaving them just as useful for boiler or hot blast stove fuel. Although the available pressure head is small, the large volume represents a considerable source of energy amounting to about 2800 horsepower when blowing 85,000 cfm.

An experimental gas turbine has been built using a thousand cubic feet of gas per minute and has been operated at Youngstown No. 3 furnace to a very limited extent to date due to necessary pilot plant alterations and other delays. One of the prime considerations is the design of the turbine buckets. It is necessary that these buckets resist the attack of the abrasive gases even though these gases will have passed through the regular dust catcher and a specially constructed multiclone before reaching the turbine. Gas is used prior to the wet cleaning processes in order that the sensible heat may be used to advantage. It is believed that the erosion problem can be solved either by use of special bucket and casing materials or further dry cleaning of the gas.

In summary, efficient high volume blowing equipment is of prime importance if one is to realize the maximum benefits from high pressure blowing.

Cold blast main — In a majority of plants the cold blast main is designed with sufficient safety factor to more than take care of the increased pressure and volume of air required for pressure operation. Therefore, little need be done on the main itself except to repair minor leaks which may develop with the increased pressure. It may be found advisable in some cases to increase the size of the snort valve.

Hot blast stove and hot blast main — It has been found from experience that the hot blast stoves of an up-to-date plant are adequate to handle pressure operation without extensive alterations. However, it is advisable to investigate the hot blast valves to make sure that they are adequate in size and strength to handle the added load. The strength of the manhole covers and inspection plates should be checked to determine whether structural reinforcement is necessary to prevent buckling due to increased pressures. Also it is expected that minor leaks may develop which can be easily repaired by welding or caulking. It should be noted here that the stoves at Youngstown are approximately twenty-five years old and needed no converting to permit pressure operation except the minor alterations mentioned above.

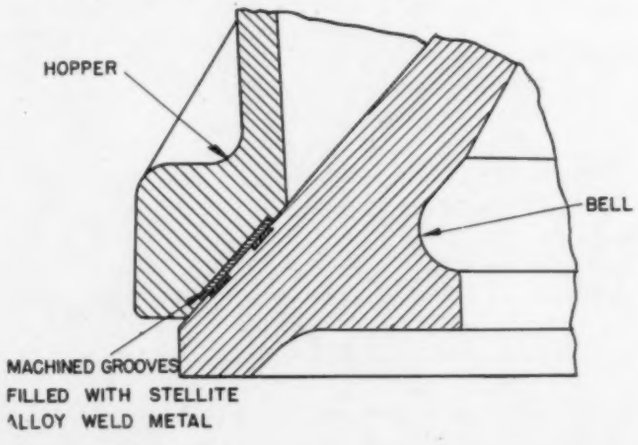
The simple problem of reinforcing the expansion joints against the higher pressure is the only important job in preparing the hot blast main for pressure operation. Of course, as in the other mains, minor leaks may develop but these can be easily repaired.

Pressure drop in the cold and hot blast mains should be held to the order of 1.5 psi in order to allow the turboblower to operate in its most efficient range.

Gas seal equalizing and relief — Because of the additional pressure resulting from high top pressure operation, it would be impossible to lower the large bell to charge materials into the furnace unless means were provided to counteract the added upward force. The adding of counterweights to the bell's understructure to overcome the increased pressure would be impractical due to the immense weight which would be required. However, if the pressure inside the large hopper is made equal or approximately equal to the furnace top pressure when it was desired to charge the furnace, the large bell can be lowered without any major alterations to the existing operating equipment. Although there have been several proposals for equalizing the pressure between the furnace top and the large hopper, the new method described below has been used successfully in present installations and is recommended for future conversion jobs. Pipe and valve sizes mentioned happen to be those in present use and are used here for convenience. Of course, the sizes employed in any particular installation are dependent on volumes and velocities desired.

In present installations, a 16 in. clean gas main is run from the outlet side of the wet washer to the furnace top, terminating in a 16 in. valve, called an equalizing valve. Beyond the 16 in. valve the line branches into two 12 in. lines running to either side of the gas seal. These two branch lines terminate at points roughly

Figure 1 — Section through bell and hopper seat showing location of hardened surface areas.



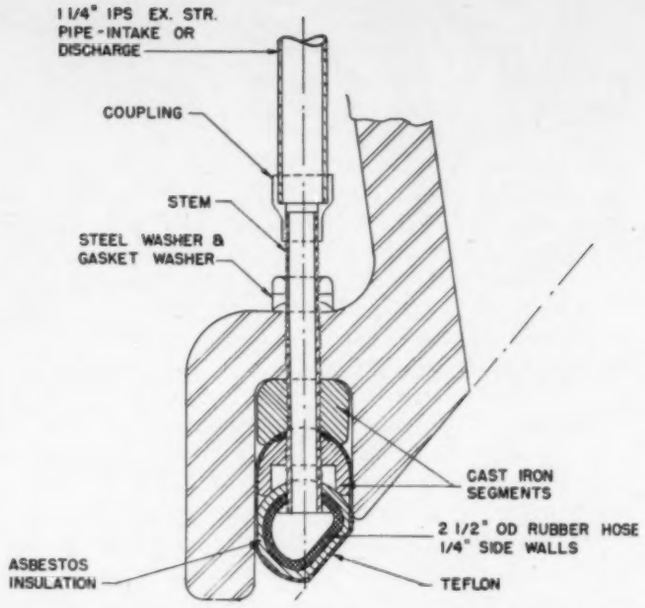


Figure 2 — Section through hopper showing use of soft seal and water connections.

diametrically opposite each other. At the end of each 12 in. line is installed a 12 in. control or equalizing valve which in turn is connected by a short run of 12 in. pipe to the gas seal. Connected in parallel with each 12 in. equalizing valve is an identical valve which is isolated under normal operating conditions by means of blank goggle plates. These spare valves can be quickly cut into the main line in the event of damage to the regularly used valves by simply swinging the goggle plates. The spare valves are used for emergency only. In the Cleveland installation, use of dirty gas for pressure equalizing is used continuously, there having been no provision made for using clean gas. However, difficulty has been experienced with lines and valves becoming plugged and eroded whereas the use of clean gas at Youngstown resulted in complete elimination of maintenance costs except for external cleaning. Therefore, clean gas equalizing systems are recommended for all future conversions.

Situated at another point on the gas seal is a 12 in. relief line equipped with a 12 in. relief valve, similar in design to the equalizing valves. In parallel with this valve but isolated from it by blank goggle plates is a spare valve for emergency use. The relief valve exhausts the equalizing gas to the atmosphere when the big bell closing operation is completed.

The opening and closing of the equalizing and relief valves is effected by the operation of compressed air cylinders which are located in the hoist house. Each valve is equipped with a quadrant to which a metal wire cable is attached, the cable running over guide sheaves to its respective cylinder in the hoist house. There are four cylinders, one for operating the 16 in. equalizing valve, one for each 12 in. equalizing valve and one for the 12 in. relief valve. It may be well to explain at this point the reasons for a 16 in. equalizing valve as well as the two 12 in. equalizing valves. Use of the two valve system, that is the 16 and 12 in. valves, makes the system more flexible to operate. For example, with the 16 in. valve closed, any part of the 12 in. lines may be worked on while the furnace is in operation. Also the two valves in series lessen the possibility of a flash-back in the clean gas lines.

The quadrant on each equalizing and relief valve is constructed with a double groove. The cable leading to the operating cylinder occupies one groove and a cable running to a counterweight is laid in the other. Thus, the valve is counterweighted shut, and the air cylinder merely opens it. Provision is made for a quick operating cable change should the use of a spare valve be necessary.

The equalizing valves and relief valve operating cylinders are operated by compressed air, the automatic control of which is effected by electrical tie-in to the blast furnace charging control system. By an adequate means of interlocking, each charging process is carried out in proper sequence and there is no chance of the pressure equalizing process interfering with the regular furnace charging operations.

A brief description of the operation of the pressure equalizing and relief system follows: While the little bell is dumping skip loads of material in the big hooper, the 16 in. equalizing and both 12 in. equalizing valves are in the closed position, and the 12 in. relief valve is in the open position, maintaining normal atmospheric pressures in the large hopper, thus permitting the small bell to open and close normally. When the charging program shows that the round, or half-round depending on the charging procedure being followed at the time, is complete and the next charging operation would normally be to lower the big bell, solenoids are energized operating three-way valves which in turn admit compressed air to the valve, operating cylinders with the closing of the relief valve, opening of the 16 in. equalizing valve, and opening of the two 12 in. equalizing valves occurring in that order. At a predetermined time after the 12 in. equalizing valves open, admitting clean gas to the space between the large and small bells, thus approximately equalizing the pressure between that area and the furnace top, the large bell is caused to lower dropping the charge into the furnace. Upon the return of the large bell to its closed position, the two 12 in. equalizing valves close, the 16 in. equalizing valve closes and the relief valve opens, returning the area between the large and small bells to normal atmospheric pressures. The pressure equalizing system remains in the above operating position until the next round is charged into the big hopper and the big bell is ready to be lowered again, at which time the program is repeated.

The installation described in the preceding paragraph can be made on any two bell top with no changes to the existing top structure or charging equipment except the tying of the cylinder operation into the automatic charging control system.

The pressure drop in the gas system through the uptakes and downcomers, dust catcher, wet washer and 16 in. clean gas main is not sufficiently great to require the use of a booster blower to permit using the clean gas for pressure equalizing. It was originally believed by many people that some sort of compressor would be necessary, but experience has proved that although there is some pressure drop through the gas cleaning system, the pressure differential is approximately one psi which is certainly less than exists during big bell dumps under normal operating conditions.

Large bell and hopper — One of the early difficulties

encountered in pressure operation was that of maintaining a gas tight seat between the large bell and hopper. The lack of perfect fit and tendency to warp of the old style multi-piece hopper design, especially at the joints, was a potential source of leaks. The extreme erosive action of the gas quickly enlarged any holes, eventually causing a halt in high top pressure operation until repairs could be made. As it was felt that the unevenness of multi-piece hopper was the main reason for the bell and hopper seat failure, plans were made to cast and machine a one-piece hopper. After the one-piece hopper had been machined in the conventional manner, a groove was machined to a depth of 3/16 in. and approximately 4½ in. wide in the seat area and a hard facing alloy was arc welded into the groove, Figure 1, after which the weld metal was ground flush with the original machined surface. A hard surface was added to the big bell seating area in a similar manner so that upon completion of the top assembly, a metal to metal contact of hard surfacing alloy was achieved when the big bell was raised to the normal closed position. To date, this hardened surface bell and hopper has been in continuous operation for fourteen months and is still working very satisfactorily. An important consideration in the installation of the large bell and hopper is to check carefully their alinement with respect to each other. They should be so alined as to seat evenly all around when the bell is raised because if the bell is slightly off center, one side of the bell will contact the hopper seat before the other, and thus set up a pendulum motion which will greatly increase the wearing of the two seating surfaces. It is thought that misalinement was a factor in the quick failure in 1944 of the multi-piece hopper under high top pressure operation.

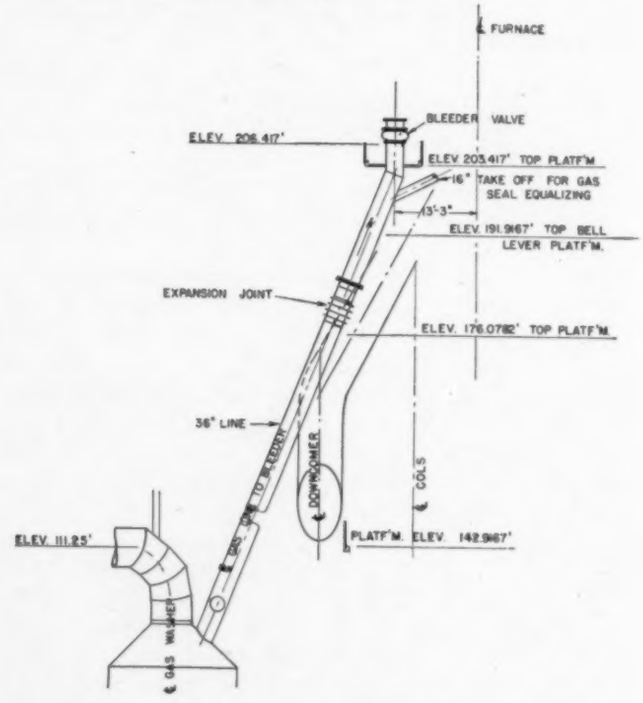
Another approach to the large bell and hopper seating problem is the use of a soft sealing material. In this connection a one-piece hopper was cast with an appendage at the seating area to hold a soft sealing material, Figure 2, against which the big bell would seat, thus effecting a gas seal for the area between the bells. Considerable research was done to find a material which would withstand the various destructive forces present at the furnace top. It was found that a new product, polytetrafluoroethylene $(CF_2CF_2)_n$ most closely satisfied the requirements of heat resistance, abrasion resistance and chemical inertness. Therefore, a water-cooled seal of this material was constructed and installed in July 1946. This seal failed after a few hours operation, but since the exact conditions of the failure were unknown, it could not be determined whether basic inadequacy of the material or mechanical faults were the cause of the failure. High top pressure operation was continued about eight months after the failure, but finally the incomplete closing of the bell, probably due to fouling of the slot with wet ore, caused a sand blasting effect by the furnace gases and dust particles, eventually wearing away enough of the soft metal in the bell and hopper to prevent further operation at high top pressure. In order that the material be given a fair trial, another seal was constructed and installed recently. This seal operated very satisfactorily for eleven days and then failed. Much fluctuation in the cooling water pressure during bell closing operations was experienced during the last few hours of operation, leading to the supposition that scrap became lodged in the hopper slot, thus cutting through the seal. Although search is being continued for a material which has better properties for this application, it is thought at the moment that the hardened surface seat is the best solution to the bell and hopper seal problem.

Bleeder valves — There has been some concern over the erosion of bleeder valves used in pressure operation. Due to the extreme erosiveness of the bled gases and the large pressure drop through the valve under high pressure conditions, the life of the standard valve has been reduced to about six months. Hard surfacing of the most susceptible parts has been attempted, but this has not prolonged bleeder life to any considerable extent.

It was thought that if clean gas could be used to relieve the furnace of excessive pressure during slipping, the bleeder valve problem could be solved. Therefore, plans were made to install a 36 in. clean gas line, Figure 3, from the gas washer discharge line to the furnace top, to terminate in a standard motor operated, positive seating bleeder valve. This installation has recently been completed. The mercoid switch controlling the operation of the clean gas bleeder is set to operate at a pressure lower than that set for the switches controlling the regular dirty gas bleeders. Thus when the furnace slips, pressure relieving is accomplished by the clean gas bleeder and the dirty gas bleeders will be opened only in those rare cases of very high slip pressures. Although the clean gas bleeder has been in operation only a short time, results to date are very promising and it is believed that its use will solve two important problems. First, the cost of maintenance of the bleeder valves will be greatly reduced. And second, the problems resulting from bleeding dirty gas into the atmosphere will be eliminated.

The bleeding of the cool gas from the wet washer also makes possible the use of a soft seat, such as rubber,

Figure 3 — Layout of 36 in. clean gas bleeder line from wet washer to furnace top.



on the clean gas bleeder which should decrease the cost and further increase the life of the valve.

Uptakes and downcomers — It has been found that conventional uptakes and downcomers equipped with standard steel wearing plates are fully adaptable to high top pressure operation.

An important factor in uptake and downcomer design and construction is making sure that all changes in direction are accomplished with smooth curves, using no flat sections which would result in a more turbulent flow of gases, hence more rapid erosion.

Some difficulty has been experienced with leaks in the lines especially where they are of old construction, but they are easily repaired by welding.

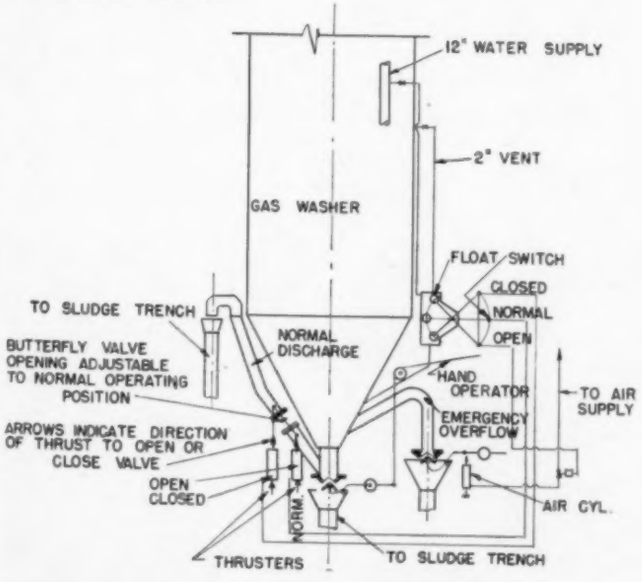
Dry dust catcher — There are no changes required in the dry dust catcher in converting to pressure operation. It was originally thought that trouble would result in attempting to empty the dust catcher under pressure, but experience with the normal pug-mill has shown this fear to be unfounded.

Gas washer — The problem of maintaining the water seal in the bottom of the wet washer when the furnace slips has given as much trouble as any single mechanical difficulty experienced thus far in high top pressure operation. Several systems have been devised and tried; the most recent being the only one that has resulted in a complete solution of the gas washer seal problem. This latest scheme consists of installing an electric thruster operated butterfly valve in the water discharge piping, Figure 4, the thruster being controlled by a float arrangement working on the actual water level inside the washer. Thus when the water level rises in the washer, the float acts to cause the thruster to open the butterfly valve, and conversely when the water level drops, the thruster is caused to close the valve. An emergency overflow is provided which automatically opens should the water level in the washer become dangerously high. If this action is not rapid enough and the water level continues to rise, a horn blows and the blower can manually dump the sludge valve. To date it has not been necessary to take this latter step.

It was felt that more detailed information regarding pressures at various given times during slips would be helpful in designing gas washer seal control and clean and dirty gas bleeder settings. Therefore, an instrument was constructed that would record accurate "slip-time," "slip-pressure," and pressure lag information. Some data have been gathered, and it is planned to prepare a paper on blast furnace slips within the next few months when additional data have been obtained.

Pressure regulating valve — Somewhere in the gas line, there must be located a pressure regulating valve to maintain the top pressure at the value desired. In present installations this pressure regulating valve or throttling valve, Figure 5, consists of a blank plate in which three thirty-inch butterfly valves are installed. Two of the valves are hand controlled and are set in more or less permanent degrees of closure. The third butterfly valve is automatically controlled by means of a regulator which opens or closes the third butterfly valve as necessary to maintain the desired top pressure. The pressure regulating valve in present installations is located after the wet washer in order that clean gas will pass through the butterfly valves, thus reducing the erosion problem to a minimum. This throttling valve has given no maintenance or operating trouble, and holds the top pressure remarkably constant except when the furnace is on second check, during which time the wind volume is very greatly decreased.

Figure 4 — The gas washer water level regulator has thruster control.



RECENT OPERATING RESULTS

The data from the two furnaces operating on high top pressure were presented by Slater[4] covering the period from their respective blow-ins in July 1946 through the first of February 1947. Both furnaces have continued to operate on top pressure since that time with the exception of the Youngstown furnace which was normal pressure for two months due to bell trouble.

The Cleveland furnace continued to operate through February on a straight ore burden, but at the end of the first week in March, 5 to 10 per cent sinter and 2 per cent scale were added and the Fe content in the burden was increased from 49+ per cent to between 52 and 53 per cent with a corresponding increase in iron tonnage.

The iron tonnage for the last three weeks in March and the month of April averaged 1552 tons per day at a dry coke of 1550 pounds per ton of iron. The wind blown was 95,600 at the turboblower and 125 pounds of flue dust were produced per ton of iron. The increase in tonnage of 7½ per cent over the 1430 tons in the September-October and January periods corresponds closely to the increase in Fe content of the burden.

The sinter in the burden dropped off to a point where it was used only intermittently, and no scale at all was charged after April. The burden was again practically straight ore. The output for the first two weeks in May averaged 1437 tons which is about the figure expected for a straight ore burden. Top pressures as high as 12 psi and wind volumes of 117,000 cfm were reached.

During June, July, and August hot spots on the furnace shell and the routine overhaul of one of the two turboblowers caused the wind and top pressure to be cut back with a resulting decrease in iron production to roughly normal pressure values. The hot spots caused by cracks in the furnace lining have since been overcome by pumping "grout" into the furnace shell.

At Youngstown No. 3 furnace, delays caused by bell

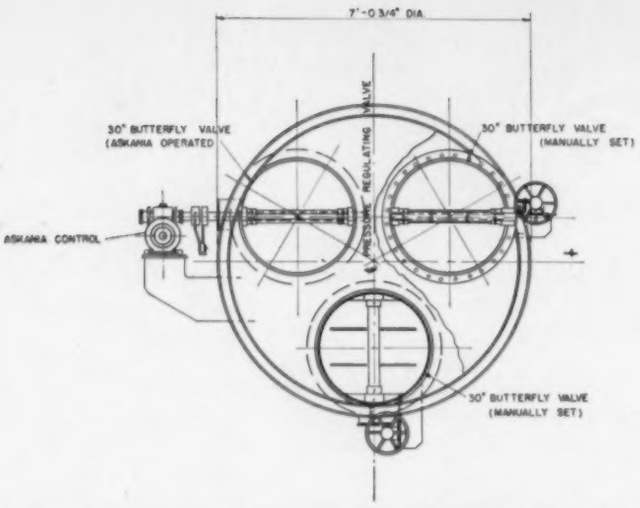


Figure 5 — The pressure regulating valve consists of two 30 in. manually set butterfly valves and one 30 in. valve automatically operated.

trouble curtailed furnace performance during March and April. The furnace was taken off top pressure in the latter part of April and operated on normal pressure for a period of two months while waiting for a new bell and hopper. The furnace was then shut down and a new bell, hopper, and $(CF_2CF_2)_n$ seal installed to permit pressure operation again.

The period of normal operation in May and June afforded an opportunity to obtain more comparative data on the furnace. The iron production for the ten-week period of normal operation averaged 1045 tons per day at a dry coke rate of 1617. The flue dust produced was 305 lb per ton of iron. These figures are admittedly better than 970 tons per day at a dry coke rate of 1705 obtained in July and August of 1946. The flue dust rate, however, went up from 278 to 305. The burden used during the May and June period contained over 30 per cent sinter as compared to no sinter used a year ago and in addition contained slightly more scrap and scale. An increase in iron production of about 80 tons and a decrease in dry coke rate of 100 pounds would thus be expected on the basis of this burden change[5].

Upon resuming pressure operation at 8 to 10 psi top pressure the tonnage increased to about 1175 and the coke rate dropped as expected to about 1500. At this point a stove had to be taken off for relining so that the present performance is below these figures.

THEORY

An increase in the average static pressure of a blast furnace decreases the volume and increases the density of the gases passing through the furnace. An increase in the average pressure thus permits more wind to be blown, and more iron to be produced without increasing the linear gas velocity through the furnace to a point where hanging, slipping, channelling, and dusting make furnace operation impractical and uneconomical.

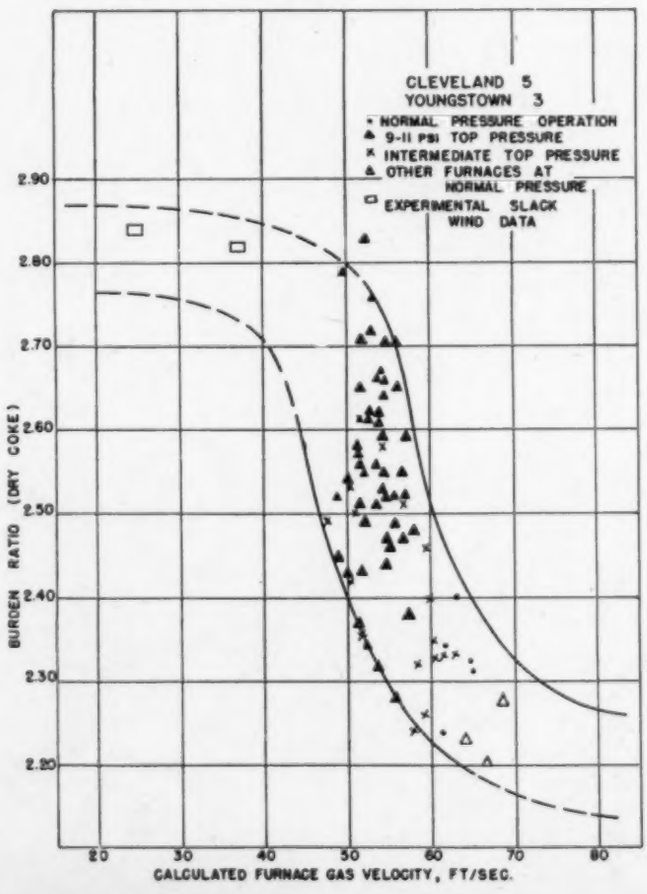
Slater[4] has shown that by throttling the exit gases, the linear velocity of the reducing gases through the furnace working volume can be substantially lowered, and new flexibility added to furnace operation. Thus by increasing the average pressure, the furnaceman can blow his furnace in any one of the three following manners and still better his normal practice:

1. Blow the furnace at substantially higher wind rates and still maintain the gas velocity at the normal value.
2. Blow the furnace at the normal wind rate and substantially decrease the gas velocity through the furnace.
3. Blow the furnace at an intermediate point obtaining a material increase in wind rate while maintaining the gas velocity well below normal.

A linear relationship exists between wind blown and iron produced so that by increasing the wind blown without at the same time increasing the gas velocity, more iron can be produced. Decreasing the average gas velocity also decreases the flue dust produced, and lowering the gas velocity just above the stock column to less than a critical velocity of about 4.5 fps for iron oxide particle carryover decreases the flue dust very markedly. In brief, pressure operation permits essentially slack wind operation at high wind rates without the low iron production obtained under slack wind conditions.

Figure 6 shows the effect of decreasing the average gas velocity through the furnace working volume on the ability of the furnace to carry a higher burden ratio. It is evident that while a furnace operating at high wind and normal top pressure has an average gas velocity of the order of 70 fps and can only carry a dry burden ratio in the neighborhood of 2.3 that as the top pressure is raised and the velocity drops, a burden ratio of the order of 2.7 or 2.8 is possible provided the top pressure is sufficient to reduce the average gas

Figure 6 — The effect of decreasing the average gas velocity through the furnace is to increase the burden ratio.



velocity to the order of 40 fps. This sharp rise in the ability of the furnace to carry a much higher burden ratio for a small drop in average gas velocity can probably be largely explained by a more uniform pattern of gas flow obtained with lower velocities and longer time of gas-ore contact. The lower coke rates and CO/CO_2 ratios obtained with pressure operation[4] and slack wind operation[6] confirm this concept.

CONCLUSIONS

The mechanical improvements which have grown out of the operation thus far have brought the pressure furnace to a point where furnace delays and lost time are now no greater than on a normal furnace. Top pressure can be used to control the velocity of the reducing gases through the furnace and thus allow an increase in wind blown with a resultant increased iron production, decreased coke rate and flue dust production, and an overall manufacturing cost saving.

Expectations of even greater tonnage increases and further cost savings should soon materialize with the delivery to Republic at the end of 1947 of the largest blast furnace blower ever constructed (125,000 cfm at 40 psi gage) which will allow operation of the Warren furnace at higher wind volumes and top pressures than are possible today anywhere in the world. Conversion of several other blast furnaces in this country and abroad to pressure operation is currently planned.

The possibility of the use of pressure operation with oxygen enriched blast and beneficiated ores is still in the future[7], but it would appear that the three should be additive to some extent. If so, furnace output should almost double in spite of our decreasing raw material quality.

The majority of the mechanical alterations necessary to convert a blast furnace plant to pressure operation are relatively minor in nature. The changes are easy to engineer and construct and, exclusive of blowing equipment, are inexpensive, averaging not over $125,000. The new features require little attention once installed and maintenance costs will be low now that minor difficulties are ironed out. Past experience will be a great help in making new conversions, and while it is doubtful if the present conversion time of five to seven days will be much reduced, the elimination of minor construction problems will make the high top pressure conversion of a pig iron blast furnace a very routine procedure. In the case of new construction the cost of the pressure blast furnace is so nearly identical to that of other furnaces as to make any differences inconsequential.

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DISCUSSION

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C. G. Hogberg: The problem of preservation of the brick lining, although not strictly a mechanical one, is certainly one of interest to those responsible for blast furnace maintenance, as well as to operators, and I wish to discuss it briefly. Those of you who have had an opportunity to examine furnaces blown out after completion of a campaign will recall that in the area above the mantle, there is almost invariably a pronounced "bellying-out" of the lining over a vertical distance extending from just above the mantle and upwards for a distance of about twenty feet. You will also recall that in the cross-section of the inwall lining there exists a definite zone of disintegration brought upon by deposition of carbon;

this zone is located away from the inner surface of the inwall and is generally more pronounced in extent and destructive effect in the upper area of the furnace.

Ceramic investigation of blast furnace linings reported by W. R. McLain in "Present Application and Possible Future Development of Blast Furnace Refractories," American Ceramic Society, Volume 19, No. 2, February, 1940, have indicated that the erosion condition in the area immediately above the mantle is probably largely due to the penetration of furnace gases of high alkali content through the brickwork. These alkalis react with the silica and alumina in the brick to form the low-melting-point mineral nepheline [(Na,K) $AlSiO_4$ $(SiO_2)x$]. A typical sample of brickwork removed from this area of the lining contained 12.3 per cent alkali, and had a melting point 624 F lower than the original brick. It is perhaps unnecessary to state that the deposition of carbon in zones of carbon disintegration is also brought about by penetration of furnace gases through the pores of the brickwork.

Since both of these types of lining disintegration are apparently initiated by penetration of furnace gases through the pores of the brickwork, it will be of interest to obtain the authors' opinion of the possible effect of changes in pressure on the quantity of gas penetration. In this connection, we recall that the published results by J. H. Slater indicate that the differential in pressure between the furnace top and bottom actually decreased under pressure operation. Since we can assume that the pressure in the space between the furnace shell and the brickwork will be substantially equal to the pressure at the stockline (because of the expansion-joint opening in the brickwork near the furnace top), the differential in pressure between the inner and outer walls of the brickwork across any plane would be lower in pressure operation than normally. Accordingly, if there is a relation between pressure differential and penetration of gases through brickwork, we would expect to have less brick disintegration of this type under pressure operation. These speculations would appear to indicate the desirability of making a ceramic investigation of the lining of the Cleveland furnace if the opportunity arises at the end of its present campaign.

With reference to Dr. Old's remarks on the possible additive effects of pressure operation, oxygen enrichment and ore beneficiation, the achievement of these additive results raises a question on the manner in which such a furnace would be filled to sustain the greatly increased operating rate. This will present a real problem to mechanical and electrical engineers.

B. S. Old: The diffusion equation has no pressure factor in it.

Graham's Law for diffusion through a porous membrane is as follows:

$$\text{Linear velocity of the diffusing gas} = \frac{K(p_1 - p_2)\sqrt{T}}{d\sqrt{W}}$$

where $(p_1 - p_2)$ = difference in partial pressure of the diffusing gas across the membrane
T = absolute temperature
d = thickness of membrane
W = molecular weight of diffusing gas
K = constant

You are correct in saying the pressure drop, that is, blast pressure minus top pressure, is less in a pressure furnace. This was first shown by C. C. Furnas of the Bureau of Mines who proved that as one increases the total pressure of a fluid flowing through a bed of broken solids the pressure drop decreases. This is affected by changes in the furnace burden and gas velocity so that one has to define carefully his conditions before applying the results of Furnas to the blast furnace.

As far as the question on the effect of pressure operation of refractories, I have no real basis for answering it authoritatively as yet. We do not expect any difficulties, and shall certainly inspect carefully the linings of the furnaces when they come down for relining. The DPC No. 5 furnace was idle for some months after the first pressure run sponsored by the War Metallurgy Committee. Inspection of its lining was made before blow in during July 1946 and it was found to be in no better than fair condition. We ran into a couple of hot spots in September that apparently were caused by a crack in the lining as they were eliminated by pumping grout in between the shell and the lining. No difficulties have been encountered with the Youngstown No. 3 lining.

J. D. Greenwood: Dr. Old pointed out that there are some blast furnace plants in this country that have new blowers with some additional volume and pressure over what is required at present. They, therefore, could be used with some top pressure.

When replacement of old blowing equipment is required, a new blower would not necessarily be charged to pressure blowing. This naturally applies to replacement of engines, in which case the investment in the blower itself will be returned in a very short time.

We believe considerable attention should be paid to the size of all new blowers. The older blowers in this country (and not very old ones at that) are invariably loaded to their maximum rating. This limiting condition in the blast furnace tonnage, of course, comes from the steady growth of the art until production outstrips the capacity of the blower. Therefore, should not the blower be selected with an eye to the future? We believe this applies now, even more than in the past, because of the possibilities of pressure-blowing, beneficiation, or the combination of both.

B. S. Old: The amount of top pressure one can carry depends on the blower pressure available. A fairly good rule of thumb is that if you add 7 psi to the blast pressure of a furnace you can add 8 psi to the top pressure. Thus many existing furnaces with 30 psi turboblowers having blast pressures of the order of 20 psi could comfortably go to 27 psi blast pressure and 10 psi top pressure.

J. L. Tatman: Referring to the experimental gas turbine brings a question to my mind — how far have you gone in protecting the turbine from the hot dirty gas? It seems to me you would have to have some type of super alloy to maintain the turbine clearances.

E. L. Pepper: It is still too early for us to say whether we can overcome the turbine bucket erosion problem. At the present we are taking gas after the dry dust catcher and putting it through a multiclone before it enters the turbine. The dust loading is still too large so that we expect to try a series type of multiclone next.

John M. Walsh: It is interesting to note how little

additional expenditure is necessary to equip a future standard furnace with the necessary equipment to permit high pressure operation at a future date. In this case, blast lines, gas lines, gas washer, stove and furnace shells all have adequate strength to operate at the top pressures contemplated at present. Changes to design necessary are:

1. Installation of a one-piece large bell hopper, replacing the standard three-piece hopper.
2. Installation of connections in the gas seal and washer for installation of between bell, equalizing pressure equipment.
3. Design of clean gas mains to allow installation of the throttling valves.
4. Installation of proper bleeder valves and controls.
5. Purchase of a blower of adequate capacity for high pressure operation, and having proper characteristics for high or low pressure operation at different volumes.
6. Installation of a thermal expansion goggle valve after the gas washer.

Under one section of the paper the authors quote Mr. J. H. Slater's paper showing that high top pressure furnaces can be operated under one of three methods:

1. Blow at higher wind rate and maintain normal gas velocity.
2. Blow at normal wind rate and decrease gas velocity materially.
3. Blow at intermediate wind rate with below normal gas velocity.

This gives a possibility of increasing the flexibility of blast furnace operation very considerably. In periods of normal or below normal ingot procuction, the high pressure furnace would be operated in accordance with Method 3, or possibly Method 2; thus, making the lowest possible coke and flue dust rates, and operating costs, while producing a near normal amount of iron.

In periods of high production requirements, the production rate of the furnace would be stepped up by operating under Method 1. Thus, management would have at hand a tool with "built-in" increased capacity at practically no increased investment cost, and which would not lie idle in periods of less than peak demand.

Frank Janecek: I do want to say that what Carl Hogberg said about filling the furnace becomes quite a problem when you charge 144 and 145 large rounds into a furnace per day.

The feeling is that most of these furnaces are right up to the maximum capacity. So, in building any new furnaces, there should be serious consideration given to adequate filling and charging equipment.

In regard to the question of blowers and to the question of wind volume, at 85,000 feet of wind under normal pressure, the velocity going into the furnace is no less than 105,000 cfm under elevated top pressure, so you are getting about 20 per cent increase in the amount of oxygen you are putting in that furnace with no increased velocity.

The mechanical parts of the operation have been pretty well overcome. We have to look at the ability to fill a furnace under these higher rates of operation, and I think that is probably as important as a larger blower.

Member: Is the present-day bosh construction with brickwork satisfactory for the increased furnace pressure, with the forty pounds pressure, you spoke of? Would there not be considerable leakage through the brickwork?

E. R. Poor: I do not think the leakage through the brickwork has been increased very much, but we have keyed the bosh plates to the bands to prevent the bosh plates from slipping out.

Robert Clark: My comments are on the stoves. I know most of the present plants have ample stove capacity, but I think that on future stove linings more attention should be paid to the combustion chamber size. There has been evidence that our combustion chambers have not been large enough; subsequently, when we get an increased wind volume, we will have a greater demand on the stoves and we will need a still greater combustion chamber size in these stoves. In future installations and new stove linings, combustion chamber sizes should be considered.

T. L. Joseph: The authors' exposition of equipment changes required for operation at high top pressures leaves little need for further comment. However, as the writer participated in planning the first tests made by Republic Steel Corporation and the War Metallurgy Committee, a few general comments may be of interest.

When the possibilities and feasibility of high pressure operation were considered in 1942, by a committee consisting largely of furnace operators, there was a need for pig iron in the war effort. Today there is a need for more pig iron and steel to gear our entire industrial machine to a higher production level in order to win the peace.

Some took the position in 1942 that all that was needed to make more pig iron was to blow more wind, to burn more coke and thus in turn make more iron per furnace. Operators realized, however, that in times of high demand for pig iron, most furnaces are blown as rapidly as possible, consistent with a reasonable loss of flue dust, regularity of operation and efficiency of operation.

As Mr. Old and his associates report, furnace practice at Republic Steel Corporation has demonstrated that both tonnage and efficiency can be increased by high top pressures, which permits higher blast, higher throughput of solids, without encountering the difficulties which normally accompany high blowing rates. Observations of commercial furnace practice and laboratory work has convinced the writer that irregular gas flow through the charge is present to some degree in all furnaces working at normal rates on Lake ore burdens. These irregularities are greatly aggravated by fast blowing. High linear velocities are the normal result of fast blowing and aggravate dusting and channelling. Pressure operation is sound in principle and has in general been so accepted because mass flow is increased by increasing the density of the gas rather than its linear velocity. However, there has been some differences of opinion as to the seriousness of mechanical problems which arise from operating at top pressures of about 10 pounds.

During slips and periods of irregular operation the furnace structure is subjected to pressures well above normal for short intervals. The application of top pressures on the order of 10 psi did not accordingly appear to offer serious structural problems. The problem of providing a gas seal between the large bell and hopper at pressures of about 10 psi did, however, offer some

uncertainties and is one of the critical features of the high top pressure operation. Fourteen months of continuous operation with a hard surfaced bell used in conjunction with a hard surfaced one piece hopper is most encouraging. Such a bell and hopper together with clean gas for equalizing the pressure between the bells seems to provide a solution to this problem. A poorly fitting bell as a result of warpage which apparently occurred in the first tests at Cleveland is certain to cut out very rapidly.

Equalizing valves to facilitate opening of the bells did not appear to offer any serious problem because the operation of such valves had been tied in with automatic charging on furnaces using gas washers which built up top pressures to a level that interfered with dumping of the large bell. However, much valuable experience has been gained on the use of clean gas to prevent clogging of connecting lines and in eliminating erosion or wear.

The pressure regulating valve as originally designed has apparently worked out fairly well and provides automatic control over the top pressure which can be held at any desired level.

The butterfly valve in the discharge from the wet washer has apparently solved one of the most annoying problems connected with the development of high top pressure practice. I think the industry owes a debt of gratitude to the men who have stuck with these problems until a satisfactory solution has been found.

High top pressures, oxygen enriched blast, and size preparation of raw materials are all promising innovations. Each of them attacks the problem of counter current flow of gases and solids in the blast furnace in a different way. High top pressure reduced linear velocities by increasing the density of the gas, oxygen enrichment reduces gas velocities by eliminating nitrogen, thus reducing the volume of gas made in burning a pound of carbon. Sizing provides more free space or passage ways for the gas thus promoting uniform flow.

Each of the innovations will increase production and efficiency within certain limits. A combination of size preparation of raw materials and high top pressure offers an interesting combination that may permit the application of blast temperatures far in excess of those now permissible. High top pressure has an advantage in that the capital investment is relatively small.

George Williams: At Indiana Harbor works of the Youngstown Sheet and Tube Company we have a furnace to be rebuilt which is now in the drawing room. A furnace of 18 ft 6 in. hearth will be enlarged to 26 ft 10 in.

I expect that this furnace will be equipped with about the same piping and equipment as has been described in this paper for high pressure blowing.

In construction, this furnace will be built in the same manner followed on one of our furnaces at Youngstown. The new shell will be built to one side, and the old furnace operated until we are ready to move the new shell into place. Since construction is not expected to begin until March, 1948 it will be at least a year from now before there is anything more to be said.

Harry O. Johnson: I am wondering how far we can go as far as coke rate is concerned. Apparently, high top pressure, the use of scrap, oxygen, and beneficiated materials will all reduce coke rates. How far can we go, or are they additive? We do not contemplate any real high top pressure at Donora. We do, however, contemplate going to possibly three or four psi, hoping to lower our coke rate. We do not wash all our gas, but just that amount necessary for the hot blast stoves, or approximately 38,000 cfm for the two furnaces. To do this it is necessary to restrict the flow of the dirty gas causing excessive wear on the butterfly type restrictor valve and the gas main.

We have experienced a definite drop in coke rates at between 1 to 2 psi top pressure. On our next campaign we are planning to operate on from 3 to 4 psi top pressure. Our blowing equipment will limit the pressure we can use.

B. S. Old: We have not operated for very long periods at three to four psi top pressure, but all our indications are that the benefits are slight until about seven psi is reached and increase more rapidly up to thirteen psi which is as high as we have gone.

You might be interested in the fact that we have been able to change top pressures pretty rapidly. At one point, the Cleveland furnace was down for a few days, due to a strike, and when they blew in, they went right back up to ten psi top pressure. In general, we have gone up rather rapidly to about ten pounds at Republic, and, therefore, I cannot help you too much on the low range.

Harry O. Johnson: I asked a question about how far we can go as far as coke rate is concerned.

B. S. Old: We have made some calculations on that, and, as you all know, calculations are not too accurate on a blast furnace. Ours were based on a straight ore burden and we believe a dry coke rate of 1380 lb per ton of iron is about as low as you are going to be able to go. We have been down that low for as long as a week at various times.

Otto J. Leone: I believe that you said something about wind blowing rates. I was wondering about the difference between the speed with which you bring your blast back to normal rate at Cleveland after a prolonged check, or temporary shutdown when you are having trouble with the furnace, as compared to the way most operators and especially older furnace men restore the wind. On most low pressure furnaces, they usually use a schedule to increase the blowing rate in small increments of, say, 500 cfm increase every ten or fifteen minutes, or per half hour, or at some other small rate.

I noticed that at the high pressure furnace at Cleveland, that after long checks or after shutdowns when the furnace is having trouble, that you restored the blowing rate from low wind to the normal full wind in just a couple of minutes. I was wondering if you would make some comment on the way this furnace is brought back faster than most low pressure furnace. Is this difference due mostly to the high pressure operation or is there something about your blower set up that permits faster restoration?

B. S. Old: An operating man could answer your question better than I. All I can say is that it is common practice at Republic to restore the full wind to the blast furnaces after a check or a cast.

John R. Green: Dr. Old made one statement this morning which concerns theory, rather than operating practice or mechanical construction. I believe the state-

ment was to the effect that the scientists say there is no difference in the rate of reducibility of the ore, when operated under high pressures. I am wondering if that statement applies to what might be termed direct carbon reduction of the ore, and whether it also applies to indirect or gaseous reduction.

I am under the impression that the ratios of CO to CO_2, and hydrogen to water vapor, and their reactions with iron oxides are all driven in an unfavorable direction by increasing top pressures. Possibly a revision of the inconclusive thinking on both dry and wet blast operation might be warranted in the light of those physical reactions at higher pressures. I wonder if anything could be added to that picture.

B. S. Old: I think the statement I made was that pressure did not affect the diffusion equation, not that it did not affect reducibility. We have made a number of calculations on the so-called solution loss business, and we do find that there is somewhat less solution loss under pressure operation. In other words, the equation which you mentioned of reduction of iron ore with carbon monoxide is affected slightly. We think it will be affected more if you go up to higher pressures. You must remember that we have not gone up but a very little bit in pressure, as measured by the physical chemists, which is usually in terms of atmospheres. Our average pressure in the furnace has gone up very little. For example, at Cleveland it was about eleven to twelve pounds per square inch average under normal operation and about eighteen to twenty under top pressure. You would thus not expect the reducibility to be affected a great deal.

Harry O. Johnson: I would like to ask one more question in regard to the fuel value of the gases under high top pressure. If you are going to have increased efficiency on the furnace, the gas values must decrease. A relatively high Btu value is necessary to operate gas engines, heat stoves, and generate steam in the boilers. How far can we go before the gas value is reduced to a point where it might not do the work it now does?

B. S. Old: Our Btu value has only dropped from the order of 90 down to about 86.5 during our low coke rate periods. We have had no trouble with the gas at these values. I do not know how far down we could go before having difficulty, but I doubt whether the Btu value would go much below 85 even at dry coke rates of about 1400 lb per ton of iron.

Carl Hogberg: In answer to Mr. Johnson's question, I can think of one way to increase the calorific value per unit volume of top gas, and that is to introduce oxygen with the blast.

J. L. Tatman: If the uptakes and downcomers must be lined with ceramics, would they not have to be rebuilt to allow enough volume and also require stronger brackets and hangers?

E. R. Poor: Larger uptakes and downcomers are not necessary because the actual gas volumes under pressure are less, and the velocities are lower. The existing hangers and brackets are deemed adequate.

B. B. Bargman: With the lower coke rates, the question of less Btu in the gas is not too critical on a unit or cubic foot basis, provided it will ignite, but the total Btu in the gas per ton of product is important. Are we going to have more or less by-product fuel (Btu) from the blast furnace for subsequent steel processing. This must be considered in the economics of this process.

B. S. Old: I think it all depends on what zone you are operating in as a matter of tonnages and coke rates, but when we were producing a lot more tons of iron, the total Btu per day went up, because, although our coke rate went down, we burned more pounds of coke per day. Although our Btu value went down, we had more total Btu per day but not per ton of pig iron.

H. C. Whiston: Preliminary calculations covering the gas-steam balance for a proposed blast furnace indicate that the steam required to operate the oxygen enrichment plant may exceed that used for high pressure blowing, and under these conditions the surplus steam or power available for other departments may be very small if any.

Member: I would like to offer a comment on the Btu content of the top gases. I think we should not overlook the fact that it is not so much a case of Btu content but of the total energy available, and with the higher pressure, if it can be properly utilized in a gas turbine, the available energy may be greater than it is in normal operation. The extra energy required to produce a higher pressure of blast is no loss. The only loss in that is the loss to the furnace, the pressure drop in the furnace, and that is about the same as before. There will be more energy available, actually, at the end of the operation.

B. S. Old: In reply to my comment regarding gas value someone made the comment that the same amount of coke would be burned over the 24 hour period resulting in the same total amount of gas produced, the energy produced being the same.

Harry O. Johnson: I would like to disagree with the speaker. I have known the gas to get so poor it was difficult to ignite, let alone generate steam or heat the stoves.

Member: In regard to that subject, I think the whole trouble with blast furnaces today is that the operation is predicated on past inefficiency, due to the fact that they do produce a gas that is high in Btu. The objective of the furnace is to produce iron with low coke rate. That gas could be enriched if you wanted to use it for fuel.

E. C. McDonald: I am quite familiar with the results that have been attained with pressure blowing and since the discussion has drifted toward gas quality I will offer a few remarks.

The gas from this furnace after stove requirements have been met is used for under-firing a battery of coke ovens and steam generation in water walled boilers. The heating value of the gas has averaged 90 Btu with a minimum of about 85 Btu, and for under-firing the battery the gas is used without coke gas enrichment.

I do not know how lean an additional coke reduction will make the gas, but so far there has been no difficulty burning the gas.

Frank Janecek: The question of the amount of Btu that gas can get came up a little while ago. Back in 1914, Brassert wrote a paper in which he stated that the pounds of coke influenced the Btu value, and the formula is: Pounds of coke per ton of iron times 0.016 plus 62½ equals Btu value of the gas, so if you had 1000 pounds of coke per ton of iron, you would have 16 plus 62½, which would be 78½, and no one is going that low.

Operation and Maintenance of Variable Voltage Control Systems

. . . . to reduce costly shutdowns, the maintenance man must become familiar with his equipment and with routine inspection tests . . . . how this can be done with relatively complicated electrical equipment is illustrated in the following paper . . . .

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▲ VARIABLE voltage control, more commonly known as Ward-Leonard control, has been used more or less extensively in the steel industry since the inception of the electric reversing drives for mills. Today it is the accepted control for main drives of hot and cold mills, and is making wide inroads into the field of auxiliary drives for these mills.

In recent years, rotating regulators of the amplidyne, rototrol, and regulex types, have reached a high state of perfection, and have been applied to the variable voltage drive, resulting in simplicity, flexibility, smooth and exact control, and lower maintenance. Various papers have been presented and published by the Association of Iron and Steel Engineers on the design and installation of variable voltage control, the Ward-Leonard systems, the amplidyne, the rototrol, and the regulex, and their applications. These papers, together with the technical data and publications furnished by the manufacturers, have enabled the steel plant technician to become thoroughly familiar with this type of equipment. This study, therefore, is based on the operational functions of these systems, circuit analysis and maintenance.

The criterion of maintenance is operational availability and perfection, therefore, to obtain this, the maintenance technician must be thoroughly familiar with his equipment, its functions, its circuits, and its idiosyncrasies.

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 22, 1947

1. WHAT IS VARIABLE VOLTAGE CONTROL

Variable voltage control circuits are those which obtain power from an adjustable potential source, the voltage of which is varied and reversed to provide acceleration, deceleration, reversal, speed and torque control.

2. WHAT ARE THE BENEFITS OF VARIABLE VOLTAGE CONTROL

Motors are constant torque drive as the entire speed range is obtained by varying the armature voltage while the full load armature current and field flux remains constant. Obviously when part of the speed range is obtained by armature voltage and the remainder by motor field adjustment, the drive is a combination of constant torque and constant horsepower. The speed range is infinite, the control is smooth and stepless as the acceleration or deceleration torque builds up quickly and constantly to a maximum value which can be sustained throughout the acceleration period.

Since the currents of the system are definitely limited, the motors are largely relieved of shock load, short circuit currents being limited to the output of the

driving generator as compared to the high value produced by a short circuit on the 250 volt mill bus.

As all control is by manipulation of field circuits with their relatively light currents, the system disperses with heavy current limiting resistors, contactors, and switches; as no armature resistors are used, the acceleration losses inherent in all forms of rheostatic control are almost entirely eliminated.

3. HOW DOES IT DIFFER FROM OTHER CONTROL

The basic variable voltage control system consists of a direct current motor whose armature is directly connected to a direct current generator with their fields separately excited, the control of these fields may be manual or automatic. With the rotating regulator applied to these drives, we obtain automatic control of drive motor performance of constant or predetermined speed, tension, power acceleration, deceleration, position, reversing, current limitation, etc., or combination of these functions.

This is in direct comparison with other control, such as rheostatic where we have heavy resistors inserted directly into the motor armature circuit to limit the current input to the motor from a constant potential power source such as the 250 volt direct current plant bus. These heavy currents require heavy duty contactors to cut in the resistors step by step for reversal, plugging, and line application. As these accelerating contactors close in sequence, we obtain a series of torque impulses from the motor, producing jerks in the gear trains and drive of the equipment. The physical bulk of these heavy duty moving parts tend to slow down the operation time.

In this particular study we are using two methods of application to illustrate the subject:

First — The operation and maintenance of blooming mill drive with variable voltage control.

Second — The operation and maintenance of screwdown operation with rotating regulator variable voltage control.

Although the basic principal of operation of these two applications are similar, their service and method of control vary greatly.

The basic method of control of the reversing blooming mill drive is shown by Figure No. 1. The reversing motor armature is connected solidly with two generators having cross compounded differential series fields, whose shunt fields are connected in series, and so arranged that they can be separately excited from a variable voltage exciter or self excited from the generators themselves.

The separately excited shunt fields of the generators are the main controlling medium, being excited from the generator exciter, which in turn is controlled by field excitation supplied by a constant potential exciter. All manipulation as to voltage and reversal is in this field circuit, a set of contactors is used to transfer these generator fields from the exciter to self excitation to provide "suicide" during deceleration, in order to offset partially the magnetizing effect of the differential series field on reverse current, thus increasing the decelerating torque.

The main drive motor has a shunt field separately excited by a constant potential generator, and a second shunt field winding that is used for series excitation by means of a variable potential generator, whose excitation is derived again from a pilot variable voltage exciter, the field of which is connected across the compensating field of the large motor. Thus the variations of the drop across this winding is magnified and used for series field excitation.

The diagram is functional, all relays utilizing the power of the closed system for actuation have not been shown for simplicity of sketch, but are incorporated in the study.

Assuming that the generators and exciters are in operation, and the board is energized; closing of the generator breakers will close the master relay No. 27, closing relays Numbers 5, 6, 7, 8, 11, 12, and 13. Numbers 5, 7, and 8 are in the exciter field circuit, No. 6 is in the generator field circuit, and Numbers 11, 12, and 13 are the field weakening contactors of the motor fields. No voltage will result from this action, as the reversers for the exciter fields have not been closed.

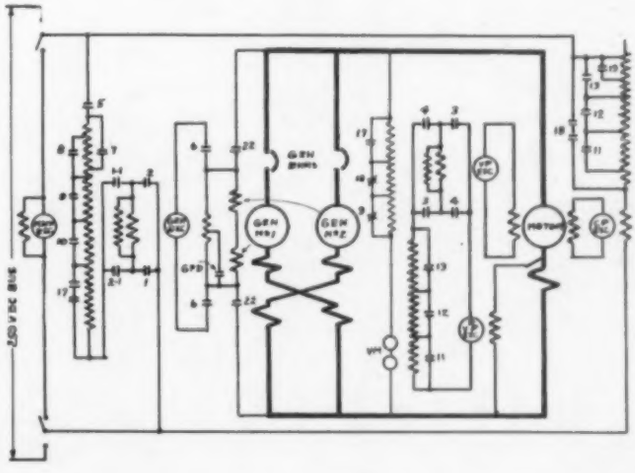
However, placing the main master switch on the first point "forward" will close relay No. 24, thus closing relays Numbers 1, 1-1, and 3. No. 1, and 1-1 are the reversers for the field of the generator which gives the forward direction of operation, No. 3 being the reverser in the motor variable potential field which sets up the circuit for the same relative direction of the motor, contactor No. 5 having been previously closed, power will now flow from the main exciter through a resistance step of the generator shunt field resistance, then to the reverser, and through the field of the generator exciter. The voltage of the generator on this point should be 225 volts. Following this action, motor will rotate in the forward direction at approximately sixteen revolutions per minute.

Advancing the master switch to the second point closes contactor No. 9, and raises the generator voltage to approximately 450 volts.

Advancing the master switch to the third point closes contactor No. 10, and raises the generator voltage to approximately 700 volts, and the speed to 50 revolutions per minute.

During this portion of the cycle, the motor main field

Figure 1 — Control of a reversing mill blooming drive is shown in this wiring diagram.



has been held to a predetermined value. There have been fluctuations in the excitation of the motor, however, due to the action of the motor variable potential field and its correlated variable potential exciter, accelerating currents in the armature of the main motor have caused a slight excitation of the field of the variable potential pilot exciter, which is connected in parallel with the compensating and commutating fields of the machine. The resultant voltage of the variable potential pilot exciter has been impressed across the variable potential exciter fields inasmuch as the reverser No. 3 has been closed. The voltage generated in the variable potential exciter is impressed on the motor potential field, the current flowing through this field therefore has been varied in proportion to the current required for accelerating the motor, and has been fluctuating in this value.

Advancing the master switch to the fourth position de-energizes time delay relay TL-1, which drops out in approximately 0.75 seconds, closing the generator field interlocking relay GF1 which is calibrated at 550 volts. This in turn drops out contactor No. 11, inserting resistance in the respective motor fields, and raises the speed to 75 revolutions per minute.

Advancing the master switch to the fifth point de-energizes contactor No. 12, further weakening the motor fields and raising the motor speed to 100 revolutions per minute.

Advancing the master switch to the sixth and last point, de-energizes contactor No. 13, again weakening the field and the motor speed rises to 120 revolutions per minute. At the same time No. 13 opens, contactor No. 19 is de-energized, and forces the weakening of the field by temporarily reducing the excitation voltage.

Since the voltage of the generator is reversed each time the rotation of the main motor is reversed, it is of course necessary to de-energize the generator exciter field before it is built up in the other direction. In order to prevent the rupturing of the insulation of the field due to the high voltage generated when the field is de-energized, a discharge resistor is connected across the field to absorb the energy during decay. It is desirable to control this decay somewhat, so as a field discharge contactor No. GFD controlled from the reverse power relay will close its contacts during periods of reverse power. The short circuiting of part of this discharge resistor by the generator field discharge contactor will retard the action of the decay of current in the field to a point which can be controlled by adjustment in the value of the resistor and in the value of the portion which is short circuited by the GFD contactor.

Forcing of the motor main field during periods of heavy load on the motor is obtained by means of a motor field strengthening relay, which operates contactor No. 18, which performs the function of short circuiting a large portion of the series resistance in the motor exciter field, thus causing a large amount of the current to flow through the main field of the motor. This motor field strengthening relay is rendered inoperative during the reverse power period by means of the normally closed contact of the reverse power relay which is open during that portion of the cycle.

Relays which utilize the voltage of the generator as actuating means are the voltage maintenance relay, generator field neutralizing relay, over-voltage relay, and reverse power relay.

Other relays which require current proportional to the load on the reversing motor are connected across the armature of the variable potential pilot exciter whose voltage varies with the load in the motor. These relays are known as the reverse power relay motor field strengthening relay, and the circulating current relay.

The purpose of the voltage maintenance relay is to bring the generator voltage up to the desired setting in a minimum of time, and to maintain it at the desired setting regardless of the load. The coils are connected across the generator bus in series with a calibrating resistor. When the master switch is on the first point, contactors Numbers 9 and 10 are open and therefore the interlocks are closed. The spring of the relay is set to balance at 0.7 amperes and the resistance is calibrated so that 0.7 amperes flow in the circuit when there is 225 volts on the bus. When No. 9 contactor closes the resistance is adjusted so that 0.7 amperes flow when there is 450 volts on the bus, and when No. 10 contactor closes the resistance is adjusted so that 0.7 amperes flow when there is 700 volts in the bus. As noted, the contacts of the voltage maintenance relay operate contactor No. 17 which forces the field of the generator field exciter and therefore maintains the generator voltage, an auxiliary contact on this relay short circuits a small amount of the calibrating resistance of the voltage maintenance relay, and acts as an anticipating means to prevent heavy surges in the generator load and fluctuating in motor speed due to hunting of the VM Relay.

The over voltage relay gives protection to the equipment in case the voltage delivery by the generator should become too high. Its normally closed contacts are in series with relay No. 27 (the master relay) and opens this relay, thus de-energizing all contactors of the control in case the voltage of the generator rises above a predetermined setting of 775 volts.

The reverse power relay is provided with two coils, one, a potential coil, is connected across the generator armature through resistors; the other, also a potential coil, is connected across the armature of the variable potential pilot exciter through resistors. The currents flowing through these coils will then vary in proportion to the load on the motor. The connections of these two coils are such that as long as power is flowing from the generator to the motor and producing work by the motor, they are differential, as quickly as this condition is reversed and the motor is pumping power back to the generator, these coils become accumulative and operate the relay, closing one contact and opening the other.

Assuming that the motor is running at 50 rpm and the master switch is placed on neutral in order to stop the motor, this will drop out contactors No. 10 and 9 and finally the reversers, weakening the generator field will be reduced to zero. If this action is taken in a rapid manner, it will be seen that the motor will re-generate power, since it has been rotating at a high speed and is deprived of an external counter emf by the reduction of the generator voltage. Its own generated voltages will therefore circulate current tending to run the generator as a motor. The value of this reverse power

would reach quite a high peak if means were not provided to limit it. The circuit of the generator field is such that the field is fed through a resistor from the generator field exciter. In order to retain the voltage of the generator at as high a value as possible during the period of time required to bring the motor to rest, the discharge resistor of this circuit can be shorted so that the time constant of this circuit can be materially increased, thus the reverse power peak will be considerably reduced. It is the function of the reverse power relay to short circuit this resistor by means of contactor GFD, which is closed only when the reverse power relay is pulled to the lower position. From the connections of the coils as outlined, it will be seen that as soon as the motor begins to circulate current through the generator, these relays will operate and provide a low speed circuit for the period of deceleration. As soon as the reverse power has diminished to a value sufficiently low to be consistent with safe operation, the reverse power relay will drop out contactor GFD and return all conditions to normal.

At times during acceleration or during heavy load periods, the torque required by the motor may be in excess of that which will be delivered by the armature at the field strength under which the motor is operating at that particular instant, without excessive armature current. This is particularly true at high speeds. In order to provide protection under these conditions, the motor field strengthening relay has been provided. Its coils are connected across the variable potential exciter armature. As the load increases, the voltage across the variable potential exciter field will increase, and when it reaches a value corresponding to the setting of the motor field strengthening relay, the contacts of this relay will close, bringing in contactor No. 18, the function of which is to short circuit a considerable portion of the resistance in series with the motor main field exciter field, thus increasing the current in excess of that normally circulated. The current in the main field of the motor will then be increased to a value considerably greater than that obtained even at full field of the motor during light load periods.

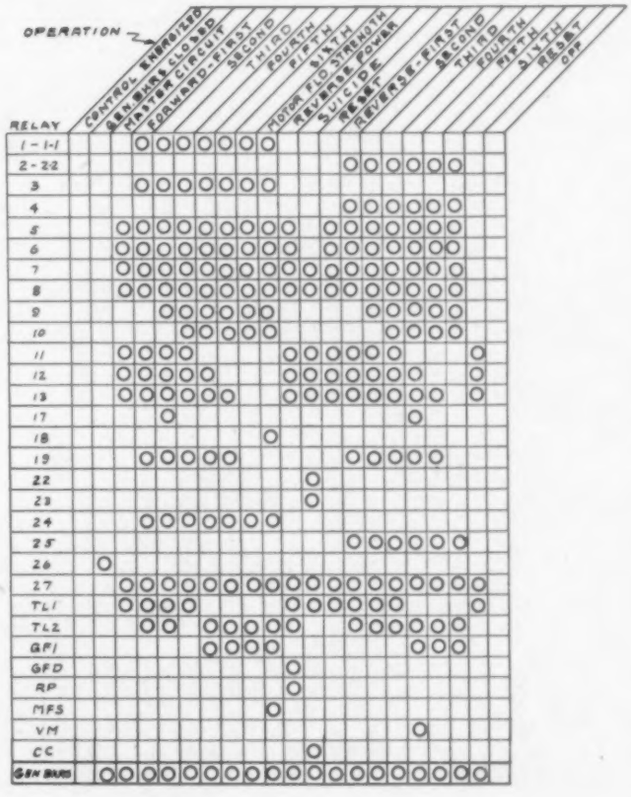
Immediately upon the strengthening of the motor field, the torque available at certain currents in the armature will be increased, and at the same time the speed of the motor will be decreased due to this field strengthening. These actions having occurred, the load on the motor will be decreased until it reaches a value corresponding to the setting of the motor field strengthening relay. When this condition has been reached, the relay will open its contacts and reinsert the original amount of resistance in series with the field of the motor, allowing the current to the motor main field to decrease to its proper value. At the calibrated value, this relay should flutter quite rapidly and serve to limit the load on the motor to the desired value of current. The speed of the motor during this period of relay fluttering will be the maximum which can be obtained with the field strength necessary to provide that limit on the current drawn by the armature.

Since this relay is purely a voltage operated device it will operate even on reverse power, at which time the closing of contactor No. 18 would be extremely disadvantageous. At that time the motor, due to field strengthening, is re-generating power, and any further strengthening of its field due to the action of this relay would increase the reverse power excessively. For this reason the contacts of the motor field strengthening relay have been placed in series with the spring closed contact of the reverse power relay, thus preventing the closing of contactor No. 18 during periods of reverse power.

The generator field neutralizing circuit (automatic suicide) is connected by contactor No. 22 across the armature of the generator. This contactor is used in conjunction with the time delay relay TL-2, interlocks as generator field reversing contactors Nos. 1 and 2 close, de-energizing relay TL-2, which closes contactor No. 23 through interlocks of motor variable potential field exciter reversing contactors Nos. 3 and 4, providing there is a circulating current of a predetermined value passing through the armature circuit of the motor and generator, thus actuating the circulating current relay and closing its interlock. The operation of contactor No. 23 opens the field contactor No. 6 and closes contactor No. 22. This circuit is maintained until the master switch is operated actuating the reverses, thus re-energizing TL-2 relay and de-energizing contactor No. 23. The contacts of No. 22 now place power from the armature of the generator directly across the field of the generator in a direction the reverse of that which has been originally applied by the armature of the generator field. The resultant action is to force the residual voltage of the generator to zero, or to a value sufficiently low to prevent circulating damaging currents in this circuit.

By following the steps of operation one by one as we have outlined, the maintenance technician can become

Figure 2 — The sequence shown is very helpful in understanding the operation of the control.



familiar with the complete sequence. Any failure along the line can be quickly isolated by observing the action of relays and the value indicated by meters. Complete knowledge of course includes familiarity with the relay schematic diagram. The complexity of the control can be greatly simplified by preparations of a sequence chart as shown by Figure No. 2. Here the contactors and relays are shown by their designation on the left hand vertical column, while the sequence operation is shown across the top of the chart.

As the sequence is carried through, say from F-1 to F-2 which is master switch position, forward, first point to second point to third point, etc., the various relays are energized or de-energized. Failures of operation of any contactor or relay can be readily located by use of this chart used in conjunction with visual check of operation.

ROTATING REGULATORS

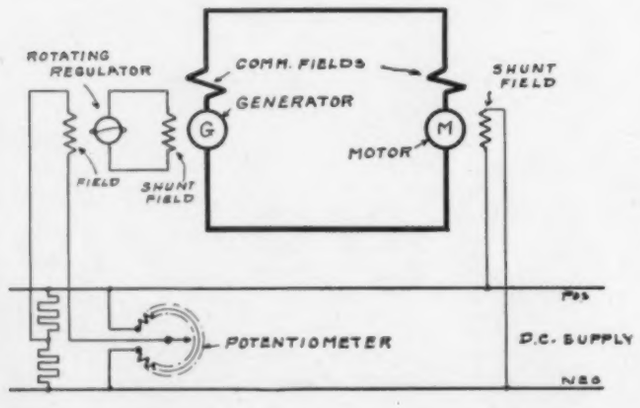
The second part of this study involves the use of the rotating regulator used in connection with the variable voltage control on screwdown service.

The rotating regulator of the amplidyne regulex or rototrol type is fundamentally an armature-excited machine, in that the armature is essentially the source of main excitation and is also the source of main power output. The first stage of amplification is from the control field to the short circuit axis, and the second stage from the short circuit axis to the power output axis, the total amplification is equal to the product of the first and the second stage amplification. They are extremely rugged, flexible, accurate, and provide smooth control.

The simplicity of the control circuit is shown by Figure No. 3, the rotating regulator being the exciter for the generator field, while the motor shunt field obtains constant potential from the supply bus. From this simple sketch it is noted that full control can be obtained from a single potentiometer control, controlling speed, reversal, deceleration, etc.

These drives therefore are operated under adjustable potential control, being started, adjusted in speed, stopped, and reversed by controlling the excitation of the generator shunt fields. The field of each generator is supplied by a regulating exciter, the output of the exciter being controlled by the manipulation of its excitation. These exciters are of the rotating regulator type, in this case amplidyne, consisting of an accumulative series field and four shunt fields. By exciting the shunt fields from various outputs of the generator, the control system furnishes the drive with voltage control and current limit.

Figure 3 — The rotating regulator is based on a relatively simple operating principle and requires relatively simple control apparatus.



Characteristics of drives with this type of adjustable potential control are:

1. Adjustable voltage (speed control).
2. Voltage regulation between close limits for a predetermined speed setting between no load and approximate current limiting setting.
3. Maximum break-away torque.
4. Current limit control during acceleration.
5. Current limit control during re-generative braking when stopping, lowering, or reversing.
6. Forcing due to over-exciting the amplidyne control field.
7. Stabilizing or anti-hunting.

For this application, two of the regulating exciter fields are connected in series to form a single control field which provides voltage control, current limiting, and forcing, while the anti-hunt field acts to restrict the voltage swings of the exciter.

Voltage control — The net excitation required for the regulating exciter control field to obtain voltage control is the resultant of the drops across a fixed potentiometer supplied from an outside constant potential source and the generator potentiometer marked GP of Figure 4.

When the drive is first started there is no voltage drop across GP potentiometer, thus the field is excited only by the drop across the fixed potentiometer, this provides a higher excitation than is required, thus causing the rotating regulator to over-excite the generator shunt field, thereby producing forcing. As the generator voltage builds up, the drop across the potentiometer GP opposes that across the fixed potentiometer and the net excitation of the control field is reduced, this continues until a stable condition is reached and the generator is delivering a predetermined voltage.

Current limit — The drop across resistance P3 is set to just balance the drop across resistance "A" at approximately 200 per cent load current, any increase in load current then will cause a decrease in the net excitation of the control field, thus reducing the generator voltage. This process will continue then until a stalled condition is reached at approximately 0.225 per cent load current.

In maintenance where the fields of the rotating regulator are disturbed for any reason, it is important that they should not be placed into service and voltage built up on the main machines until the polarities of the control fields are checked and adjustments made. Since the net excitation is the differential of two or more sources of excitation, one field alone will produce many times the flux required and force the output voltage to the saturation point. Therefore, when checking these fields one at a time, do not use more than one tenth of normal excitation. A single dry cell battery will provide ample excitation.

Forcing — The amount of initial forcing can be increased or decreased by varying the resistor "CF," this may also require a slight adjustment in resistor

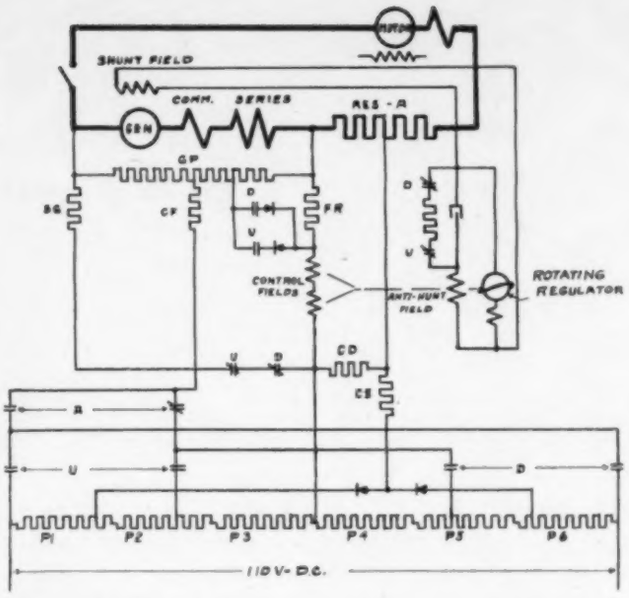


Figure 4 — The rotating regulator control described is used for variable voltage control on screwdown service.

"GP," so that the rotating regulator field will still receive normal excitation when the generator delivers rated voltage.

Variable voltage (speed control) — A slide wire or multi-tap fixed potentiometer would provide an infinite speed control from 0 to maximum. In this application only two speeds are required (high and low), which are obtained by the use of relay "A." On the first point of the master switch, relay "A" is de-energized and on the second point relay "A" is energized, this applies partial and full voltage, either positive or negative to the excitation circuit when the direction relays are actuated from the master switch. If it is desired to vary the amount of generator voltage attained, this can be done by varying resistor GP, this will however affect both high and low speeds, the low speed can be changed independently by varying the tap on the fixed potentiometer resistors P2 for up direction, and P5 for down operation.

Cut-off and stalling — At a certain cut-off point the generator voltage decreases rapidly with increase in load. This point can be changed by adjusting resistor P3 for one direction and P4 for the opposite direction. As the load increases, the drop across resistance "A" becomes greater, thus opposing the current flowing through the control field more and more until a stalled condition is reached. This stalling point can be changed by adjusting resistance "CS."

Plugging — The plugging characteristics can be made to equal the accelerating characteristics by adjusting tap V3 on resistance GP, thus varying the plugging current. The accelerating current can be varied by adjusting resistance "FR."

During deceleration when centering the master switch, suicide is obtained through resistance "CF" causing the generator voltage to drop rapidly. This amount of suicide can be varied by adjusting tap V on resistance "CF."

Artificial voltage drop — On a drive such as this, where one motor is served by one generator, it is desirable to initiate an artificial drop in the generator voltage, to provide better commutation under high overloads and to keep the machine within its designed range as determined by its volt-ampere curve. The magnitude of this drop can be adjusted by means of resistor CD.

It is important that in making any adjustments to these circuits, that the calculated data furnished with these machines by the manufacturers should be closely adhered to.

The modern design of variable voltage equipment and control, including the rotating regulators have been perfected to a high degree of reliability, and are sufficiently elementary in operation to be understood by non-technical maintenance personnel.

Shutdown or loss of production time in practically any industrial process is costly, but in the continuous process of steelmaking an unexpected interruption may incur a loss in production alone of greater value than the first cost of the device causing the failure.

In any case, failure to function successfully is the result of failure of some component part, device, or circuit, which should be readily and quickly apparent to the maintenance man.

Furthermore the approach of such a failure should be determinable by familiarity with the equipment, and routine inspection of the apparatus involved.

DISCUSSION

PRESENTED BY

J. RAYMOND ERBE, Metal Working Engineer, Industry Engineering Department, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

WALTER H. BURR, Superintendent, Electrical Department, Lukens Steel Company, Coatesville, Pennsylvania

C. B. HUSTON, Commercial Engineer, Industrial Engineering Divisions, General Electric Company, Schenectady, New York

J. Raymond Erbe: In thinking about this subject, we thought it would be of interest to show a typical roll table application. The general arrangement is shown by Figure 5. This drive consisted of a front main table driven by two 150-hp motors permanently connected in series, a front feed roll table driven by a 75-hp motor, a back feed roll table driven by a 75-hp motor, and a back main table driven by two 150-hp motors permanently connected in series.

Each table is driven by a separate variable voltage generator. In this case, a third motor-generator set was supplied as a spare to provide uninterrupted operation. With this arrangement, the spare generators can be switched to replace either of the regular generators as may be required.

Although three motor-generator sets were used, only two exciters were supplied. Each of these is full capacity and can excite two motor-generator sets, all of the table motors, and their associated control. This proved to be

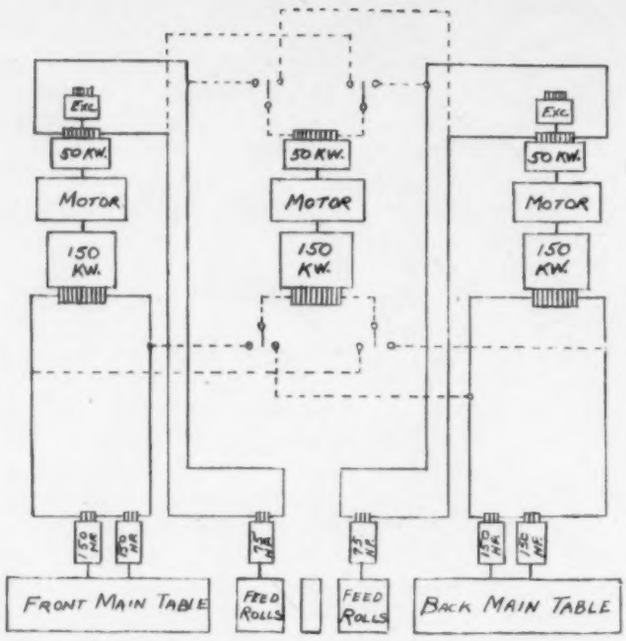


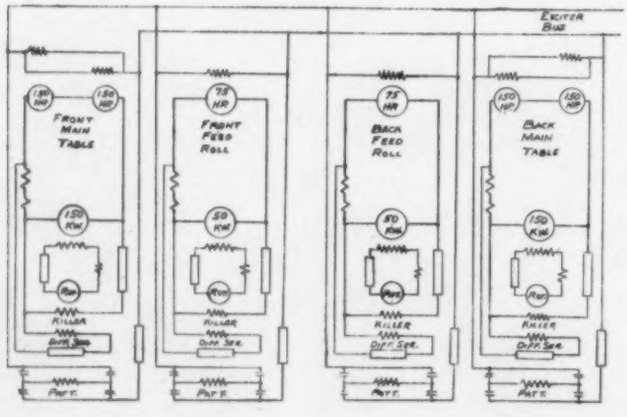
Figure 5 — The application of variable voltage to a roll table drive is shown in this sketch.

more economical than using three exciters of smaller size and could be done as two motor-generator sets are required to operate the entire drive.

In the past, it has been fairly general practice to use three field, shovel type, generators for an application of this kind. In this case, however, shunt generators were used and rotating regulators were supplied to provide the desired characteristics. Figure 6 is a partial schematic sketch showing the connections. The regulators were used to excite the generator in each case. A killer or suicide field was provided so that the drive would not tend to creep from the residual generator voltage. This field is excited from the drop across the generator terminals. A differential field, which determines the rate at which the generator voltage is built up, is excited from the drop across the generator series and commutating fields. The pattern field is excited from the drop across the exciter bus and is used for reversing the table drive.

The curves shown in Figure 7, were plotted from test

Figure 6 — The schematic sketch shows the rotating regulator connections for a variable voltage roll table drive.



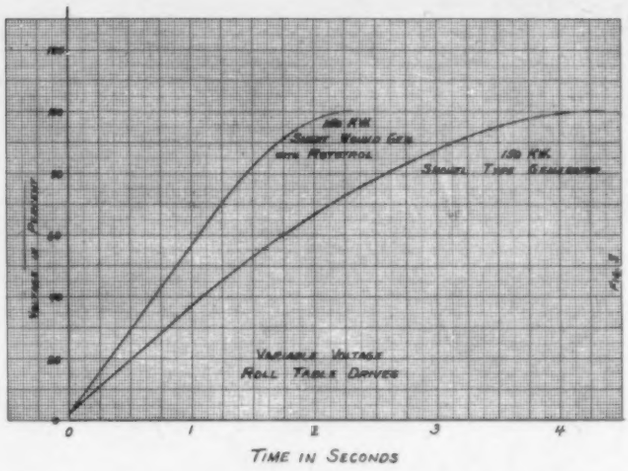


Figure 7 — This drawing shows the relative time to increase the voltage for a shovel type generator and a shunt wound generator, with a rotating regulator. Build up with rotating regulator is approximately twice as fast as that with the other type.

data on these two types of table drives. It is to be noted that it required 3⅛ seconds for the voltage to build up to 90 per cent of normal when the shovel type generator was used. However, with the rotating regulator this time was reduced to 1.7 seconds or 54.5 per cent. This is probably as fast as it will be desirable to accelerate roll tables, because this rate, we believe, approaches the limit at which the rollers will slip under the steel.

Walter Burr: After listening to this paper on modern control, it might possibly be well if we stopped and went back to the type of control which was being used at the time the Association was formed. Brent Wiley, the late managing director of the Association, described in a paper in 1906 what was then one of the first main roll drives installed in the steel industry. It was installed at the Edgar Thomson works of the Carnegie-Illinois Steel Corporation, and consisted of two 1500-kw d-c motors, 235 volts, operated directly off of the 230 volt d-c generating system in the plant. These motors were designed for 125 rpm at no load, 100 rpm at full load, which permitted the drive to take advantage of the 125,000 lb flywheel which was direct connected to these d-c motors. To me, the interesting part in the whole drive was the control which was very unique in that there were 105 30-lb rails and 295 40-lb rails connected in such a way that they could be insulated with fire brick. That constituted the control for the d-c motors on the first main drive installation. Certainly it is a long step from that type of control to the control which we have heard described this morning.

C. B. Huston: Operation and maintenance of adjustable or variable (whichever we wish to call it) voltage control systems is a very broad subject. Our friend Mr. Howry has presented two outstanding examples, the blooming mill for one and the screwdown for the other.

Except for this very early installation to which Walter Burr has just referred, I dare say all blooming mill control conceptions have been Ward-Leonard, so that when we consider this type of mill, be it blooming

mill, slabbing mill, the reversing structural mills, or of like character, we definitely are talking about the adjustable voltage control. It only remains to mention briefly the stages of development that such controls have advanced.

To begin with, we excited the fields of our generators and motors from a constant potential source, usually a common exciter. Contactors were used to obtain the various points and with them a multiplicity of relays to govern the voltage at the various points. We had a control which was a great improvement over the type that Walter Burr referred to, but the field circuits are very difficult to handle. They are very inductive and they are high in current values. You often have 300 to 400 amperes just for a motor or a generator field, maybe two or three generator fields in series or in multiple to be controlled as a unit. The maintenance naturally will run high on a control of that sort.

We next pass to stage No. 2, where the controls for the fields of the motors or generators were handled by exciters, and it then becomes necessary only to control the fields of the exciters. This naturally is quite a step forward, but we still have a large number of relays, a large number of contactors, special voltage maintenance and current limit control devices, all of which add a great deal of complexity to the system.

Then we come to the third stage in the development of this kind of control. This embodies the regulating type of exciter which may be used either direct or indirect. The first of this type of controls was placed in service in the summer of 1939; the second one in May of 1942. Since that date our company alone has built or is building a total of 31 such controls for blooming mills. This shows the advancement that has been made in this line of equipment.

We might ask, "What are the advantages of the newer type or stage No. 3 development?" The principal one is a reduction in the number of devices required. I dare say that there is only 50 per cent of those needed in the previous types of control equipment. Furthermore, these devices can be very small. They are all alike. That in itself adds to simplicity. It reduces maintenance. Not only that, but this type of control is inherently suited to the purpose. You can automatically maintain the voltage that you want at any point to which you throw the master switch. You inherently have voltage maintenance. It does not require separate relays for that purpose.

Furthermore, you can regulate the field of the motor to any value that you wish. You can cause the motor field to increase with the load. You can approach the characteristics of a compound-wound machine if so desired. You can do everything that you have previously been doing, and then some, and you do it much more easily.

When we come to the Ward-Leonard type of auxiliary controls, we enter an entirely different field. There we definitely pass from the stage of magnetic or armature resistance type of control to the adjustable voltage type. I do not know just when the first installation of that type was built, but approximately fifteen years ago. I do know that when these drives were first considered the operating people said, "We have been accustomed to operating our auxiliaries from a constant potential source which we know is always present. Therefore, we must have some means of backing up these adjustable voltage systems with spares and with alternate circuits." As a result, for the first few that were built, the control panels looked like Christmas trees, with transverse switches taking the circuits here and there from one generator to another. With some usage the operating people have gained confidence, and the equipment in itself has demonstrated its reliability, and, therefore, these bulkly transverse switches are gradually disappearing. We now have extremely simple circuits such as Mr. Howry has already shown to you.

The armature circuit can be a self-contained circuit. The field circuits are likewise self-contained. Each and every drive is electrically independent of the other and stands on its own feet.

There have been many advancements in the Ward-Leonard type of controls as applied to heavy duty mill auxiliaries. Initially the three field generator construction was used, but this is now replaced by the amplidyne type of control. The number of control devices has again been reduced; the size of the devices is smaller, all of which is reflected in increased reliability, lower maintenance, and, therefore, greater service to the steel industry.

I can recall twenty years ago when considering a tandem cold strip mill, we discussed with the prospective customer how well he could do their job with Ward-Leonard, but, no, they could not see their way clear to spend the money for the additional generating capacity allocated to that particular mill. The equipment was built with magnetic control, and I say that that equipment was out of date at the time it went into service. What would we do now with our high speed mills if we did not have adjustable voltages of Ward-Leonard control?

Then came along the direct current drives on table run-outs, where we have a multiplicity of motors, 100 or more, and how would we ever have controlled these except by Ward-Leonard? The same can be said of the coilers that follow these hot strip mills, and the shears that cut up the material when we want sheared sheets. So, we can go on and on forever outlining the uses of Ward-Leonard and how it has increased the facilities of the steel companies. We have only to look at the processing lines, and surely with all the different drives that had to be coordinated in the processing line you have extreme difficulty in trying to do it in any other way than with Ward-Leonard.

There is one feature of Ward-Leonard control to which I especially want to call attention and which is frequently neglected. This applies primarily to the heavy duty auxiliaries such as blooming mill screwdowns — live tables — side guards — bloom shears, etc.

Ordinarily with constant potential power source these drives are equipped with compound wound, or occasionally series motors. The motors, therefore, produce high torques at high loads. The greater the load current, the greater is the flux for producing torque.

Ward-Leonard control implies the use of shunt wound motors. The normal shunt field adjustment gives the same flux as that obtained on a compound-wound motor at its normal full load rating. The torques of the two motors at this point are the same. At higher loads, however, there is not the same increase in torque, due to increased flux, unless some means are provided to force the shunt field. This feature should not be neglected when considering this type of drive.

Preparation of Coal FOR COKE PRODUCTION

. . . . coke with a stability factor of about 40.0 gave good blast furnace operation, but reducing the factor to 37 adversely affected such operation . . . . increasing stability to 45 had little effect . . . .

By PRESTON E. JORDAN
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▲ THE preparation of coal for coke production is a subject that is receiving more and more attention due to the influence of coke quality on blast furnace operation, and also due to the fact that the remaining good coking coals are fast being used.

During the early history of coke production, little attention was given to the selection of or preparation of coal for metallurgical use. If a coal had sufficient agglutinating power to form coke, other factors were largely overlooked. During recent years, coals which will produce a satisfactory coke have been selected if available. If not economically available, existing coals have been beneficiated by selective mining, blending, and cleaning to produce the desired coking properties.

Before discussing preparation methods, we should understand just what end product we are to produce. This brings us to the need for coke specifications. Unfortunately blast furnace men do not seem to agree on just what properties a good coke should possess. This is quite understandable since the blast furnace is a chemical retort of such magnitude that isolation of an individual factor is almost impossible. For the purpose of this paper, however, we are giving a number of generalized statements of coke quality which we believe to be important and toward which preparation processes lead. These are:

1. Uniformity as to chemical composition.
2. Uniformity as to physical properties.
3. Low ash, sulphur, phosphorus and other elements detrimental to steelmaking.
4. Sufficient stability and hardness to withstand crushing and abrasion in the blast furnace.

In addition to these requirements, metallurgical coal must not swell so much during the coking process as to damage oven walls and must shrink enough on the completion of coking to be easily pushed from the oven.

The preparation of coal for coke production may now be defined as any mining practice or processing after mining that alters the coal in such a manner as to produce a coke conforming to the above requirements. Such preparation may be accomplished by the following operations:

1. Selective mining.
2. Blending.
3. Cleaning plants.
4. Pulverization.
   a. Moisture control.
   b. Oil treating.

SELECTIVE MINING

The requirements as to low ash, low sulphur and uniformity may be met by selective mining. Coal seams are so lacking in uniformity that the whole seam can seldom be used for metallurgical purposes. For instance, the thick Freeport seam is overlain by a varying thickness of high sulphur coal. The usual practice, when this seam is mined without cleaning, is to cut just beneath this layer and remove the cuttings for fuel before removing the metallurgical coal. If the high sulphur layer is later removed it is also used for fuel. This practice may reduce the sulphur content of the metallurgical coal produced by about 0.3 per cent. This seam also carries a band of bone about 12 in. thick. In most cases this is "gobbed" in the mine. This practice will reduce the ash content by about three per cent.

From the above it will be seen that selective mining

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can produce a superior product. However, due to economies made possible by mechanized mining, such practices are giving way to full seam mechanical mining and cleaning plants.

BLENDING OF COAL

Under the subject of "blending of coal," we propose to consider the blending of coal from high and low ash and sulphur sections of the same mine in such a manner as to secure a product uniform in mineral constituents and which will produce a coke uniform in physical properties.

The bio-geological processes responsible for producing coal covered such long periods of time and were so varied in character as to produce a most heterogonous product. It is not uncommon to find that the ash and sulphur content of the coal in adjacent sections of a mine will vary as much as 1.5 and 1.0 per cent, respectively. It is also likely that the mineral constituents of the coal substance itself will vary from point to point. The physical properties of coke produced from coal in adjacent sections are also known to vary considerably. For examples, lower Kittanning coals from the various mines in Somerset County, Pennsylvania, are known to have widely different swelling properties. The cleaning of such a coal will reduce sulphur and ash and other minerals, but will not necessarily give complete uniformity. Cleaning will also alter the physical character of the coke produced from the coal due to the removal of inert particles and to changing the moisture content. However, lack of uniformity will still exist.

The only practice which can produce a uniform product from a mine is a systematic blending scheme. A cleaning plant cannot accomplish a good blending job due to the fact that a continuous stream of coal passes through the equipment which can only remove impurities differing in specific gravity.

From the above it will be seen that systematic blending should be combined with cleaning if maximum beneficiation is to be achieved.

CLEANING PLANTS

The cleaning plant is the second method by which the ash, sulphur, and other harmful minerals may be reduced in metallurgical coal. Cleaning plants in general operate on the principle of difference in specific gravity of the coal substance, and the ash, sulphur, and other impurities.

The new cleaning plants are so efficient that in general a very low ash content product can be produced. However, due to economic consideration, a reasonably low ash metallurgical coal is produced in an attempt to get a high recovery. When possible, two types of coal and the waste should be produced. These should be a low ash, low sulphur metallurgical coal and a high ash coal for fuel. This process permits thorough utilization of all the values in a mine.

For instance, in the thick Freeport seam under full seam mining and using an efficient cleaning plant, a good metallurgical coal of less than 10 per cent ash can be produced along with a steam coal containing about 25 per cent ash and a Btu value of about 11,000 per pound.

PULVERIZATION AND STORAGE

The coke plant operator has but little control over the coal he processes prior to its arrival at his plant. In the plant he does have control over storage and pulverization. Both of these exert considerable influence on the stability, hardness, and perhaps porosity of the coke. For this reason, storage and pulverization should be considered as methods of coal preparation.

Storage causes changes in coal due to oxidation or weathering as it ages. The Bureau of Mines has shown that the agglutinating power of coal decreases with increase in oxidation. In fact, the loss of agglutinating power is used as a measure of oxidation.

At Wheeling Steel, we have found that a slightly stronger coke can be produced from thick Freeport coal by blending 25 per cent of partially oxidized with fresh coal. We have also found that the coking properties of this coal deteriorates at an accelerated rate after about three months loose storage. This means that a coal with oxidizing properties, such as, the thick Freeport, must be thoroughly rolled in if it is to be stored for any length of time.

This brings us to the thought that uniformity of physical properties may be endangered by storage. The oxidation properties of each coal should be studied and each should be stored according to these findings. An effort should be made to oxidize each increment of a given coal to the same degree if uniformity of physical properties is to be retained.

Along with the effect of oxidation of coal on the physical properties of coke, we recently noticed a handling problem, namely, wet oxidized coal tends to stick in the hammer mill at pulverization of about 80 per cent through an $\frac{1}{8}$ in. square screen, and about five per cent moisture content. This trouble occurred while using baskets with 1 in. round holes in the hammer mills. One basket in each mill was replaced with another having $1\frac{3}{8}$ in. openings and the pulverization reduced to about 75 per cent through the $\frac{1}{8}$ in. screen. No further trouble was experienced after this change. Fresh coal had worked well under the first conditions.

Pulverization, as mentioned above, is another practice that has tremendous influence on the coking properties of coal. For example, the stability factor of coke produced from a given coal may be varied from 35 to 45 by varying pulverization from 60 to 85 per cent through the $\frac{1}{8}$ in. screen. In our case, there are apparently two reasons for this; first, the more intimate mixing of the high and low volatile coals that we use produces a uniform coke and not an agglomerate of pieces of coke from lumps of the two coals. Coal particles must be quite small if solution of the two coals in each other is to be accomplished, and this is necessary if a single type of coke is to be produced; second, inert particles present must be reduced to less than 20 mesh in size if they are to become a source of strength instead of a source of weakness.

From the above, it will be seen that finer pulverization, up to and perhaps beyond economic practice, should produce stronger and stronger coke. Our ex-

perience up to 85 per cent pulverization indicates this to be true. We recently ran two batches of 28 ovens of a coal mix through our plant — the first batch with a pulverization of 72 per cent through a ⅛ in. screen produced coke having a stability of 39, while the second batch with a pulverization of 83 per cent produced coke having a stability of 46. This is a direct increase of 0.63 stability units per one per cent increase in pulverization.

Data from another of our plant tests covering a period of six weeks when other factors were held reasonably constant produced coke with a stability factor of 45.5 when the coal was pulverized to 82.2 per cent through the ⅛ in. screen. This coke was followed visually to the blast furnace skip. It was observed that but little degradation occurred due to handling. Large blocky lumps up to about 4 in. square predominated. This was in sharp contrast to the 38 stability coke we had produced a few weeks before from the same mix at a 70 per cent pulverization, which had broken up to much smaller pieces by the time it reached the skip.

During the past year, we have varied pulverization from 70 to 82 per cent and obtained data which gives correlations of r=0.53, 0.58 and 0.74. The data giving r's of 0.53 and 0.58 was obtained under normal operating conditions; the data giving 0.74 was obtained under controlled conditions. The values of r of 0.53 and 0.58, while not so impressive numerically as the 0.74, nevertheless are highly significant since other factors, such as, moisture content, are known to have reduced correlation.

In the examples given above, stability has varied directly with pulverization at a ratio of about 0.65 to 1.0. Our data also seems to indicate that a straight line relationship may be assumed over the usual operating range of from about 60 to 85 pulverization. This means that an equation of the form $Y=MX+K$, where Y= stability, M=the slope of the line, X=pulverization, and K=a constant, should correlate pulverization, stability data. For coals we have investigated, M= about 0.65. This will vary with coals having different coking properties.

Along with our work on pulverization and stability, an attempt was made to correlate blast furnace production and coke stability. We have not been able to accomplish much in this direction. Visual inspection of the data indicated small changes in production with changes in stability. However, no real correlations were obtained.

During the six weeks period when stability averaged about 45.5 and when the coke looked so good in the blast furnace skip, little additional pig iron was produced over an earlier period when stability averaged about 39.0. This was most disappointing, especially after the significance that has been attached to coke strength in the past.

This, and other similar data, seems to indicate that coke of some minimum stability is required for a blast furnace. This minimum stability may be the strength required to resist crushing and excessive abrasion in the furnace. Additional strength and hardness, no doubt, have some value in further resisting crushing and abrasion, and in providing uniformity of size, of coke entering the furnace. This would assist in maintaining uniform filling, and, therefore, be of value.

Higher pulverization, by increasing the stability of the coke produced from a given coal mix, will allow the production of coke of sufficient strength, with, in our case, less high cost lower Kittanning, low volatile coal.

For example, we are now producing coke with a stability of 39.0 by pulverizing a mixture of 85 per cent thick Freeport and 15 per cent lower Kittanning coal to 75 per cent through the ⅛ in screen; whereas, we formerly used 20 per cent of the more expensive lower Kittanning coal at about 65 per cent pulverization.

CONCLUSION

In conclusion, the preparation of coal for coke making should start in the mine. Selective mining should be used if the coal produced is not to go through a cleaning plant. Every effort should be made in the mine, and in the cleaning operation, to produce coal low in ash, sulphur and other harmful minerals, and uniform in composition. During storage, greater uniformity should be achieved, if possible. However, in working for chemical uniformity by bedding, physical uniformity of the coke produced should not be impaired by allowing differences in oxidation to creep in.

In pulverization the operator has an effective process with which to improve stability and hardness of coke without the use of excessive low volatile coal. This allows an economic balance between cost of low volatile coals and the cost of pulverization to be made.

There is some evidence supporting the proposition that a minimum stability and hardness is necessary for blast furnace coke and that stability and hardness in excess of this minimum has decreasing value. Coke with a stability of about 40.0 seemed as good as that with a stability of 45.5 in our case, while with stability as low as 37 it seemed to adversely affect furnace operation.

DISCUSSION

PRESENTED BY

C. VANCE THOMPSON, Crucible Steel Company of America, Midland, Pennsylvania

PRESTON E. JORDAN, Technical Advisor, Wheeling Steel Corporation, Follansbee, West Virginia

KENNETH McCUTCHEON, American Rolling Mill Company, Ashland, Kentucky

O. L. HENRY, Republic Steel Corporation, Cleveland, Ohio

C. Vance Thompson: I would like to ask Mr. Jordan if he has been able to correlate any connection between per cent moisture in coal with the structure of the coke?

Preston E. Jordan: We have not tried that yet. We expect to go into that when we get our new experimental oven into operation.

Kenneth McCutcheon: In testing the coke, what kind of sample have you taken to determine the stability of the coke you are referring to?

Preston E. Jordan: We use the ASTM stability machine.

Kenneth McCutcheon: I mean how is the coke sampled?

Preston E. Jordan: We took the best coke we could find and checked it in the ASTM tumbler for stability.

Kenneth McCutcheon: My question was directed at the remark you made to the effect that there is no correlation between stability and the results obtained in the blast furnace. The results obtained in the blast furnace are the complete "testing" by the blast furnace of the coke produced. Is the sample you use taken every eight hours or is it continuous sample over twenty-four hours?

Preston E. Jordan: We take a large sample every eight hours, over a thirty or forty minute period. This is cut down to proper size for a stability sample. We run each shift separately, and average the three values for our daily results. A portion of the discard from each large eight hour sample is accumulated for a weekly shatter test.

O. L. Henry: I wish to say that the work at Wheeling Steel verifies what we have been doing in our own laboratory and the work we have done in the Bureau of Mines. There is a definite correlation between pulverization and the quality factor. Where we found the greatest difference was on coal with a high percentage of extraneous ash. On coals having no extraneous ash, there was practically no difference. However, those tests were made on unblended straight high volatile coals.

AGITATION OF THE BATH WITH COMPRESSED AIR IN THE LIQUID METAL PROCESS

By OSCAR PEARSON

Superintendent No. 2 Open Hearth

Gary Steel Works

Carnegie-Illinois Steel Corporation

▲ DURING the period between November 25 and December 14, 1947, thirty-four heats were made in No. 57 furnace in the Gary Steel works No. 2 furnace shop, using compressed air. The experiment was limited to 0.04/0.07 per cent carbon rimmed and mechanical capped grades because previous experience had shown a slow rate of carbon elimination as the carbon in the bath reached low levels of concentration and a corresponding increase in heat times in obtaining the low tapping carbon necessary to meet the specification. Compressed air was used around the clock on each heat of the above-mentioned grade made in the No. 57 furnace, except when the air pressure was too low for effective results. A group of 34 heats of the same grades made in No. 57 furnace during the period of November 12 to 24, 1947, without the use of compressed air, was selected for a comparison of heat times and production rates.

One inch extra heavy pipe in 20-ft lengths was used for lances and the lances were inserted singly in No. 2 or 6 doors, depending on the direction of the flame, as longer pipe life resulted when the lances were inserted under the flame. Air pressure was 48 pounds per square inch. Ore additions were made at the normal time intervals and the practice was to insert the first lance at approximately 0.18 per cent carbon, usually immediately following ore addition. Two pipes were generally consumed per heat, although occasional heats required three and others only one.

A 9.6 per cent reduction in charge to tap time due to a 22.4 per cent reduction in melt to tap time was found for the heats made with compressed air, while production in tons per melting hour increased 10 per cent. Visual examination indicated a more than normal rate of roof erosion, especially at the No. 2 and 6 door locations where the lances were usually inserted. An increase in front wall and door lining erosion was also noticed.

USE OF OXYGEN AND COMPRESSED AIR IN THE OPEN HEARTH

By M. F. YAROTSKY

Div. Supt. of Steel Production, South Works

Carnegie-Illinois Steel Corporation

▲ EXPERIMENTATION at South Works with the use of oxygen and compressed air in the open hearth furnace has been limited to determination of their effect on furnace operation when used to promote flame development. The following conclusions are indicated by results to date:

1. Increased production rates over those obtained on the balance of the shop were realized in all experiments with higher firing rates provided the charging time for scrap was below two hours.
2. The use of high firing rates with or without compressed air or oxygen with protracted charging times or hot metal delays results in high fuel costs with little or no benefit in production.
3. The use of oxygen or preheated compressed air introduced below the oil with double burners resulted in the highest production rates as measured by tons per melting hour.
4. The economic advantage in the use of oxygen over preheated compressed air for flame development when used with a double burner may be difficult to justify, since the differential was not too significant.

Multiple Fuel Burners

FOR OPEN HEARTH FURNACES

. . . . multiple fuel burner design requires detailed and careful consideration of all the factors that enter into efficient combustion . . . .

By J. M. BRASHEAR
Assistant Superintendent
No. 2 Open Hearth Department
Inland Steel Company
East Chicago, Indiana

▲ MANY factors are operative in an open hearth furnace which affect the burners. In order to develop the subject of multiple fuel burner equipment logically, it is advisable to consider the objectives common to all burner equipment. These are twofold, heat delivery and maintenance of atmosphere. Some of the subsidiary factors, not entirely independent of each other, are worthy of consideration in detail. It is not possible to satisfy each of them to the ideal extent regardless of the fuel or burner equipment. Furnace pressure, draft, radiation from the walls and bath, preheated air temperature, fuel-air ratio, steam-oil ratio, degree of atomization, and the effect of the flames on refractories are of primary importance for consideration.

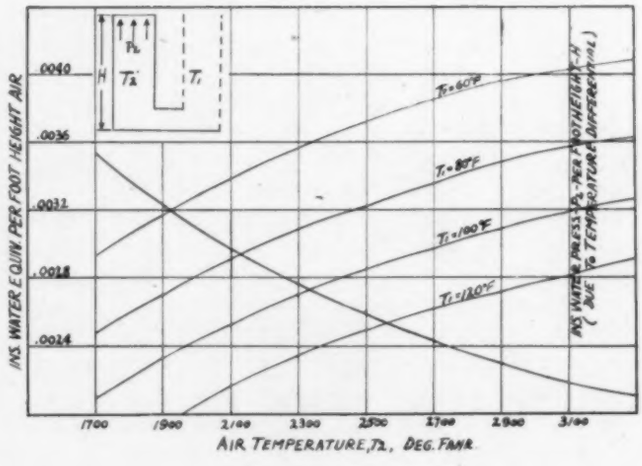
Many articles have been published in the technical literature on the behavior of combustion gases within the furnace, articles describing studies of the emission spectra and temperatures of hydrocarbon flames. There has been but very little published information on the logical relationship of these, and other factors, with the burner equipment.

The burning of liquid fuels such as tar, residual oils, pitch separately or in combination with coke oven, natural or other types of gases is not new. The burner equipment used on most furnaces is crude and shows little development from an engineering standpoint to that used many years ago. Probably the reason for this slow development has been due to the many complex and varied problems presented. The open hearth furnace and process presents far more problems in combustion practice than almost any other type of industrial furnace.

To attempt to discuss fully the many variables which influence the burning of the various fuels in an open hearth furnace and the characteristics peculiar to each fuel and to the process itself is beyond the scope of this discussion. The relation of burner and flame control to quality of product and fuel consumption is quite definite. The essential reasons for control are twofold: first, to insure a uniform quality of production by maintaining furnaces at the best operating temperature; and second, to maintain the efficiency of the fuel application by adjusting the burner equipment to operate at its highest efficiency.

It should be borne in mind that operating temperature is not a direct function of heat input, but rather a function of heat input and the heat requirements both of the furnace and the work. The rate of heat transfer is complicated by the size and shape of the furnace, surface exposed, specific heat, and other properties of matter. Of all the factors involved in the design of burner equipment, there is probably none about which

Figure 1 — This chart shows experimental heat head pressure values in inches of water equivalent per foot of column height.



Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 25, 1947

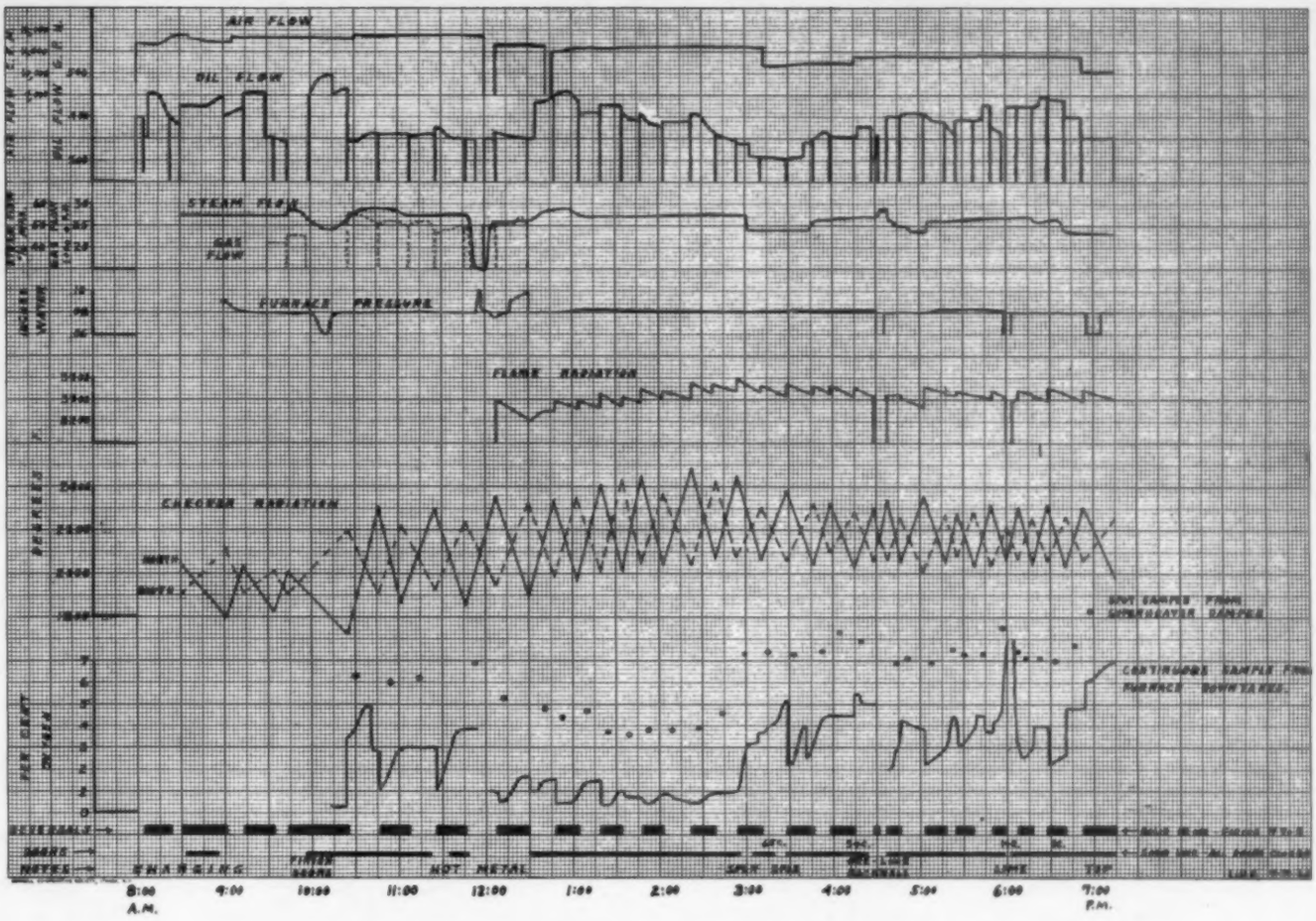


Figure 2 — This chart gives combustion data on a typical open hearth furnace heat.

is less positively known than the limiting figures of heat which can be liberated per cubic foot of combustion space.

The practice of installing oversized burners so as to be certain of the heating capacity may therefore be carried to an extreme.

Efforts have been made to correlate ignition velocities, heating values and the maximum heat delivery capacity for given combustion volumes.[1]* It is not known whether the maximum heat delivery occurs coincident with mixtures having maximum ignition velocities.

To better control these "inherent variables" and to compensate for their influence on burners and burner design, studies must be made and probably some changes made in the design of the furnace.

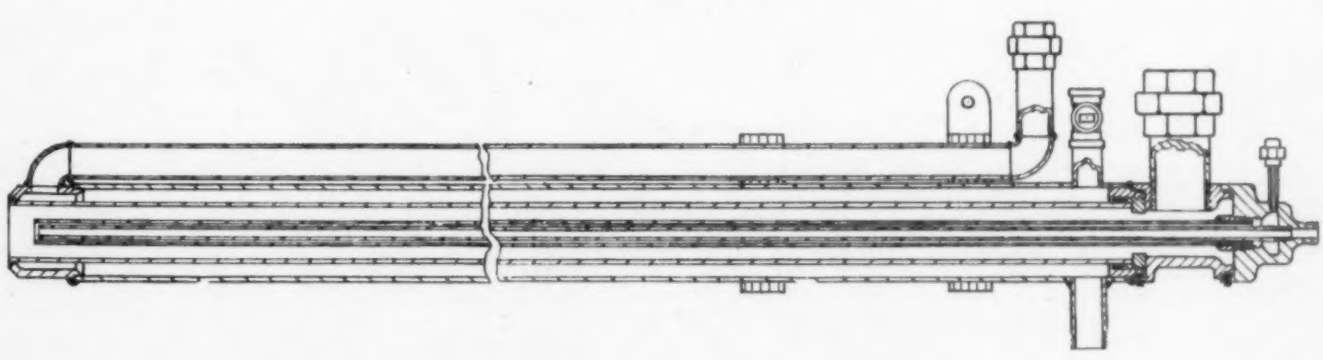
It is often more difficult to measure accurately the changing conditions within the open hearth system than it is to correct or at least to control the quantities contributing to the change of these conditions.

FURNACE PRESSURE

Furnace pressure conditions within the open hearth furnace play an important part in the direction and

*Numbers refer to bibliography at end of article.

Figure 3 — This drawing shows the multiple fuel burner now in current use. Burners might either burn fuel oil, coke oven gas or tar.



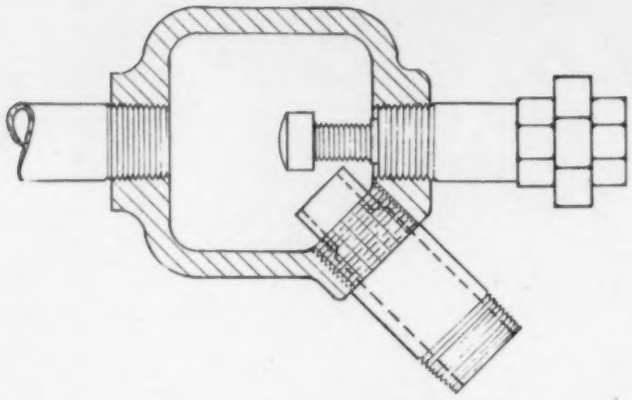


Figure 4 — The atomizer in use is illustrated in this sketch.

location of the flame, the temperature, and heat distribution. The range of pressure is appreciably higher at the roof level than at the bath level due to the stack effect in the furnace. This same relationship exists at the ends of the furnace. The differential increases as the temperature rises. Pressure measurements taken at furnace bridgewall levels on either outgoing or incoming ends are normally zero. Below this level, they are normally minus and above this level they are normally positive. Their values increase or decrease correspondingly with the temperature variations in the areas. Since the pressure conditions are relative and vary with operating conditions, their influence on the flame is considerable. This is due largely to their effect on the volume and flowing conditions of the incoming air over the furnace bridgewall and into the fuel stream. Since most of the pressure and differential variations are the result of stack effect, the pressure values are the result of kinetic rather than static conditions and do not lend themselves readily to control at this point.

Methods and equipment have been developed to measure accurately the small changes in pressure conditions within the furnace. In general, these devices control the pressure within the furnace by varying the negative pressure controlling the removal of the waste gases from the furnace. The impulse or pressure tap generally is located near the center of the main roof.

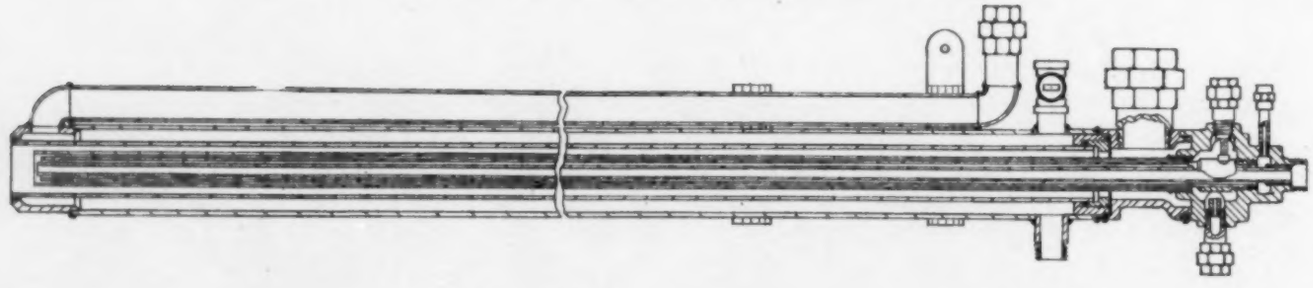
This type of control satisfies the purpose of maintaining uniform hearth pressures only. However, it complicates other factors which have a marked bearing on the efficiency of the flame. Recent studies have shown that uniform furnace pressures are not desirable throughout the entire heat cycle. A study of Figure 1 showing some experimental heat head pressure values in inches of water equivalent per foot of column height for air will explain this a little more clearly. While these values were developed in experimental work in a closed column, relative values can be established for both static and kinetic factors through the checkers and uptakes of the furnace which, of course, function as modified open columns. The point at which the incoming preheated air strikes the fuel column after it passes the furnace bridgewall is governed to no small degree by pressure variations in heat heads at this point and by the temperature of the preheated air itself. It can be shown that air and gas flows through the checkers are influenced in a like manner.

FUEL-AIR RATIOS

The rate at which the fuel is burned in the open hearth furnace depends largely upon the temperature and volume of the air supplied, and the rate of mixing or contact of the fuel and air in the combustion area. The proportion of fuel to air, the temperature of the air, and the mixing rate determine to a large degree the temperature and characteristics of the resulting flame.

Methods and equipment have been developed to measure and control accurately the proper amounts of air required for combustion. The somewhat disappointing results obtained in either increasing the heat input or flame temperature, and the probable reasons for the poor results obtained, has been shown in earlier discussions by the author.[2] Two factors interfering with available proportioning methods are the effect of bath reactions on air requirements for complete combustion, and the infiltration of varying unmeasured quantities of air into the regenerative system. To establish the degree to which these two variables affect combustion and to make suitable adjustments, it would be desirable to base the control of fuel-air proportioning on a continuous record of oxygen in the outgoing gas. Experimental work has been conducted during the past two years in our shops and is being continued. While it might be desirable to control air input by means of oxygen measurements, this practice is hardly feasible with the furnace conditions currently existing in most open hearth shops. Future work with equipment of this type will necessarily depend on techniques developed to measure and control the total air input. The heat described in Figure 2 shows graphically the general results to be expected on the average furnace operating under accepted practices and employing most of the accepted controls and instruments for open hearth work.

Figure 5 — This sketch shows the location of the atomizer on the burner.



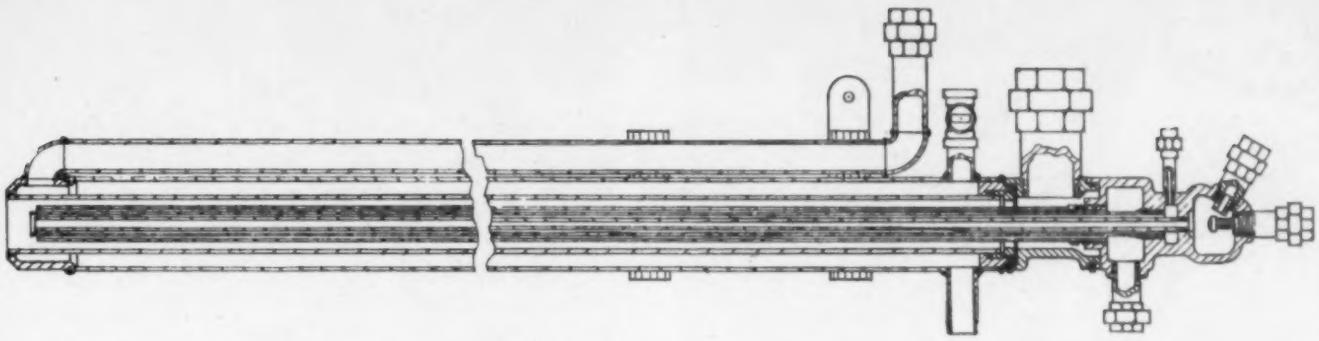


Figure 6 — This sketch shows the burner modified to use oxygen in the combustion. Flame temperatures about 250 F higher than normal were attained with the use of oxygen.

STEAM-OIL RATIOS

A primary feature governing the thermal efficiency of any liquid fuel burner is the correct proportioning of the steam used for atomizing. Most liquid fuel burners in use today are of the steam atomizing type. This type of burner was introduced into industrial heating work about 1901.

Many types of mixers or atomizers have since been developed and described in the literature but investigation will reveal that little improvement has been effected in their efficiency or design. The construction of the atomizer in most common use today in most open hearth furnaces still consists essentially of a tube or nozzle inserted into one opening of a standard pipe tee and extending slightly in front of the other opening which is at right angles to the tube. The third opening is used to permit the discharge of the steam-liquid fuel mixture to the burner pipe.

The introduction of steam into the liquid fuel stream serves only one major purpose, that of breaking up the liquid fuel into as small particles as possible so that they may be delivered to the furnace in a finely divided state for more rapid and complete mixing with the air required for combustion.

A considerable amount of discussion has been focused on this subject. Generally it has been directed as to what temperatures and pressures of both the oil and fuel are most conducive to desirable flame characteristics and fuel efficiency.

During the past four years, experimental work has been carried on studying the influence on flame temperature by varying steam temperatures, pressures, and volumes, liquid fuel temperatures, pressures, and viscosities. It was found that the temperature and volume of the steam rather than the pressure was quite important; likewise the temperature and its relation to viscosity, of the liquid fuel.

Variation in the composition and properties of the various oils available today makes it necessary to provide some means of compensation for such variations. One of our first attacks on this problem was the installation of an automatically controlled central oil heating station in each open hearth shop. Fuel oil is tested daily for viscosity, and control corrections are made to maintain an SUS firing viscosity of 130 to 135 seconds irrespective of other properties. Tar (although seldom used) and pitch are handled in the same manner. This permits the use of the same burner and atomizer for all three fuels.

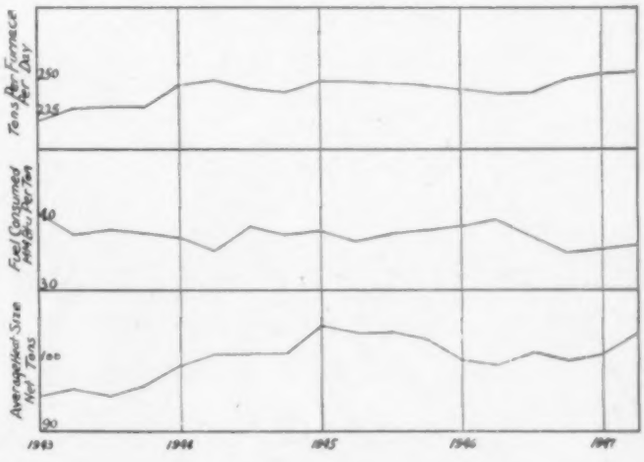
No benefits were derived from the use of high temperature steam. It was found that steam temperature in excess of 550 F were of no value in increasing the flame temperature and the use of higher temperature steam generally resulted in increased atomizer and burner maintenance.

Comparative data studied on pressures used in several plants revealed only the varying pressures reported indicated a local means of attempting to control steam-fuel ratios and burner velocities according to their requirements.

The logical relationship of firing pressures and burner discharge velocities can only be fully evaluated for one size and design of furnace. It does appear, however, that steam-volume relationships are stable enough to permit their use on several types of atomizers and are not wholly dependent on the furnace or burner design.

Results of experimental work conducted on steam-fuel ratios indicate that maximum flame temperatures are obtained using between 2.6 to 3.1 pounds of steam per gallon of oil or tar fired, and 2.9 to 3.3 pounds of steam per gallon of pitch fired. Generally it has been the practice of the furnace operator to supply the same volume of steam at all firing rates of fuel and especially to not reduce the volume of steam when firing mixed fuels such as oil and coke oven gas. This was found to result in much lower observed flame temperatures, whereas approximately the same flame temperature

Figure 7 — Operating data on the 100-ton furnace from 1943 to 1947 are shown in this chart.



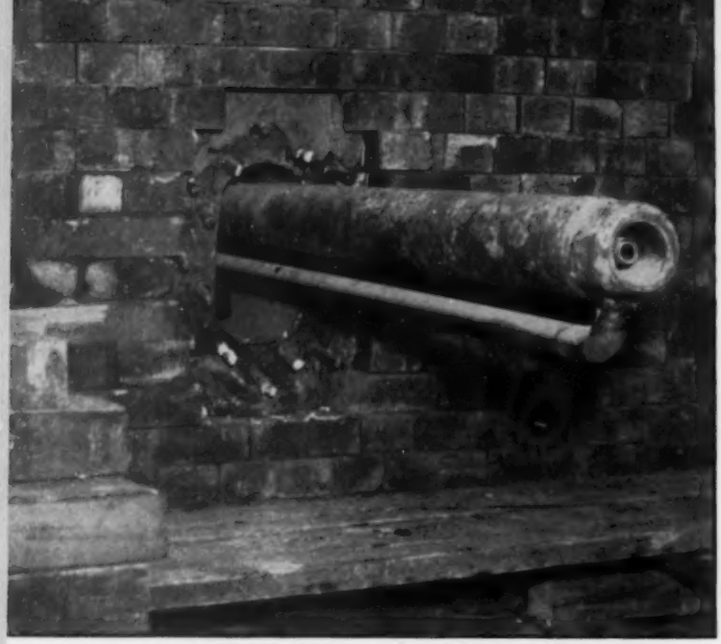


Figure 8 — Burner assembly inside 175-ton furnace.

Figure 9 — Front of burner assembly used in 175-ton furnace.

could be maintained by reducing the steam volume directly as the liquid fuel volume was reduced. These ratios were found to hold for multiple firing to approximately 35 per cent of the total fuel input as coke oven gas. Flame temperatures dropped slowly from this point up to the use of 50 per cent of the total fuel as coke oven gas, at which point flame temperatures dropped rather sharply.

BURNER DESIGN

The multiple fuel burner currently in use in our shops is shown in Figure 3. Development work was started on this type of burner in 1940 in our No. 1 shop, and was installed on all furnaces in 1943. The 175-ton furnaces in our No. 2 shop were equipped in 1944. These furnaces are equipped to burn fuel oil and coke oven gas. The 175-ton furnaces are also equipped to burn tar.

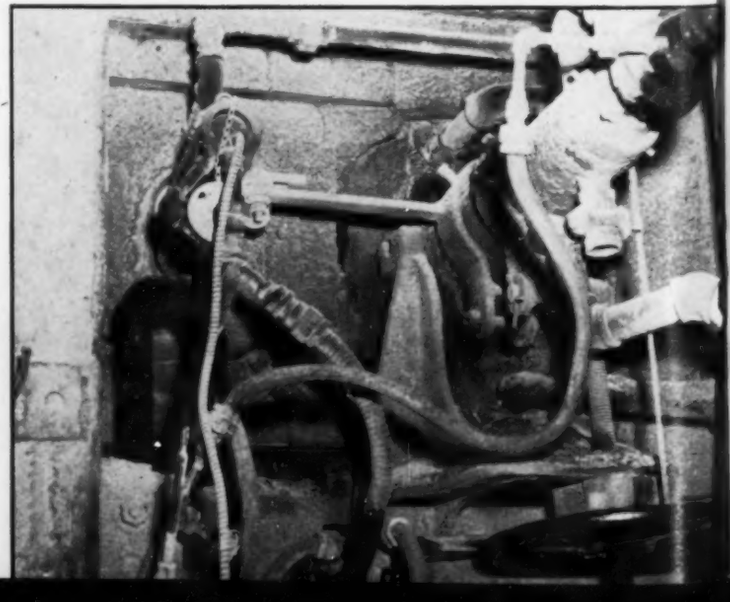
Several different types of atomizers have been used with this burner; however, best results have been obtained with the atomizers shown in Figures 4 and 5. Automatic end valves of conventional design are in use on several furnaces but have not been accepted as standard due to the high maintenance involved. Atomizers are located on the end buckstays of the furnace approximately 6 feet from the entrance end of the burner.

Referring to Figure 3, it will be noted that the discharge of the liquid fuel is in the center of the coke oven gas discharge port. Due to the difference of opinions (expressed by several engineers and operators), relative to the merits of eccentric versus concentric discharging type burners, variations in the position of the liquid fuel pipe was made and the results on flame temperatures studied. Several arrangements of multiple jets were also tried. All of these experiments were disappointing and all failed to produce average flame temperatures equal to the arrangement shown.

Figure 6 shows the same burner arranged for firing multiple fuels with oxygen. Oxygen of high purity was supplied to the fuel stream in our initial experiments in July and August of 1946 using the coke oven gas chamber of the burner. Satisfactory results were obtained using oxygen in this manner and flame temperatures approximately 250 F higher than normal were obtained. However, this arrangement precluded the use of oxygen when firing liquid fuel and coke oven gas in combination.

Experiments were conducted after changing the burner head assembly so that an additional tube could be inserted to permit the use of oxygen at the same time liquid fuel and coke oven gas was being fired. The first experiments were conducted using the center tube for oxygen, the second tube for liquid fuel and the outer tube for coke oven gas. Flame characteristics, when using oxygen, were comparable with those in the initial experiments. However, the roar from the burner was very great and quite objectionable to the operators.

Figure 10 — Shown here is the flame temperature mounting in the furnace.



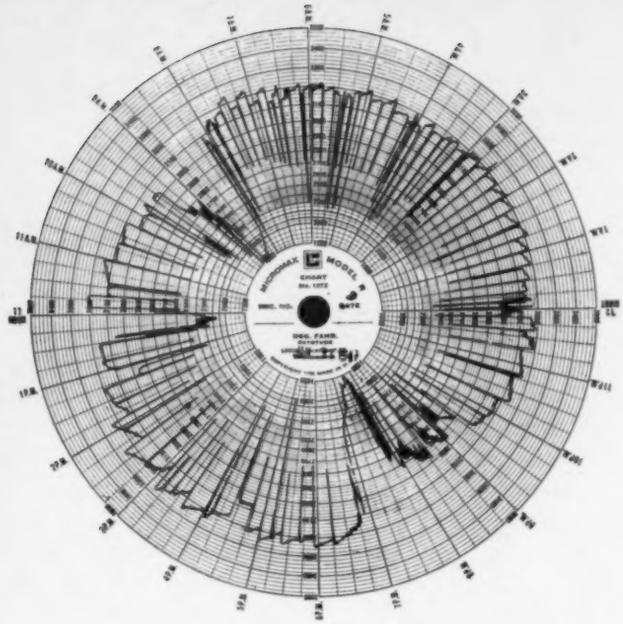


Figure 11 — A typical record of flame temperature is shown on this flame temperature chart.

When the oxygen was shut off and the burner was used in conventional fire, disappointing results were obtained both in flame temperature and characteristics.

The tube arrangement shown in Figure 6 has proven very efficient and has been adopted for furnaces equipped to use oxygen, supporting combustion. Referring to Figures 3 and 6, it will be noted that the liquid fuel tube is surrounded by another tube slightly larger in diameter than the liquid fuel tube.

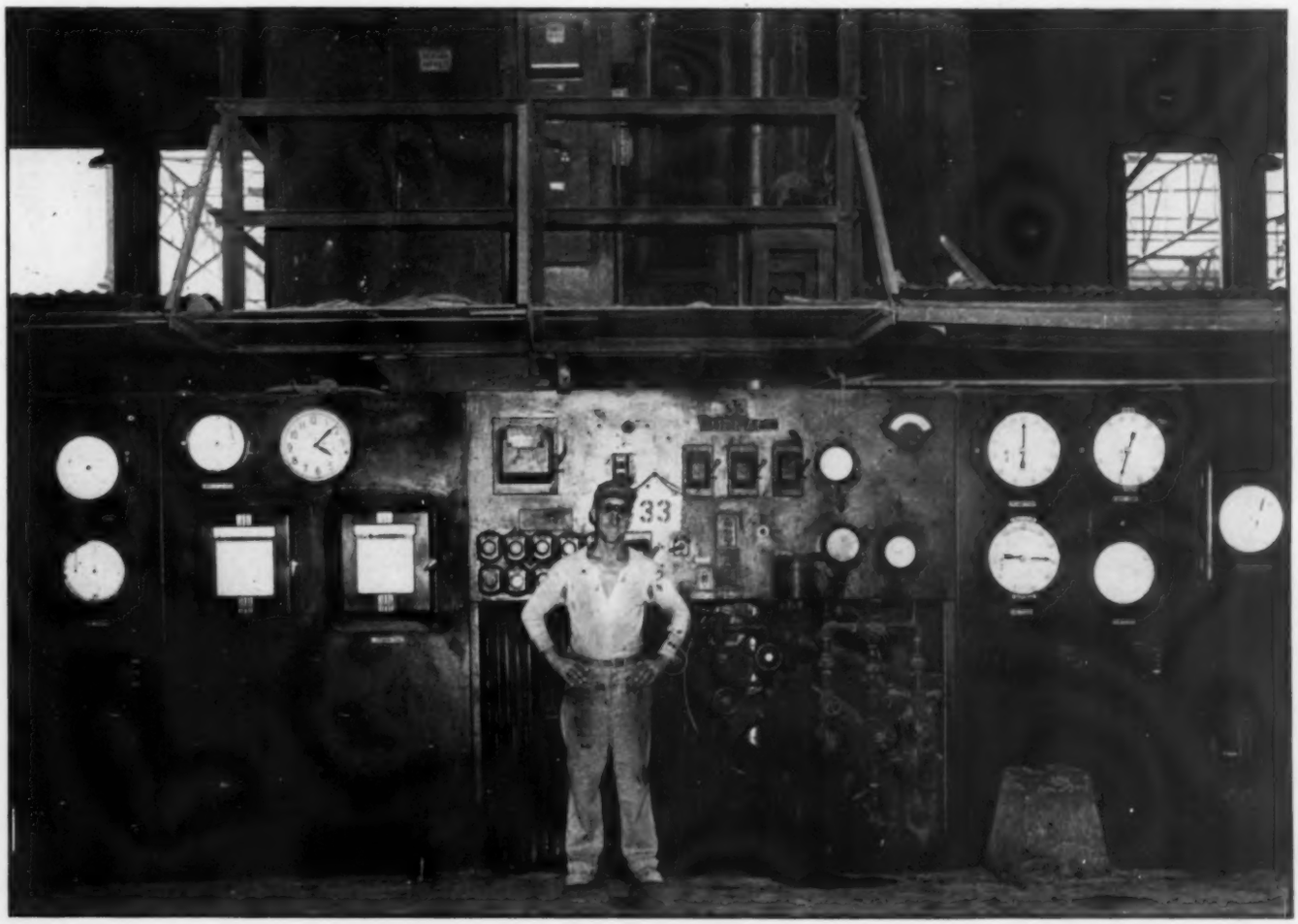
This tube was added to avoid the use of the so-called "back pressure steam" commonly employed in most burner designs on the "dead" end. It also provides a means of additional heating for the liquid fuel and perhaps insulation from the cooling effects of the water jacket especially when firing pitch which in our case has an SUS viscosity of 135 at 345 F.

SUMMARY

The burner equipment described briefly in this discussion has made it possible to study many of the subsidiary factors associated with the heat delivery and maintenance of atmosphere in an open hearth furnace.

The primary benefits derived from its use are: a burner which can readily be adjusted to suit melting conditions in the furnace; can be adjusted to compensate for furnace wear; reduces materially the restriction in the throat and uptake areas by elimination of the "doghouse" construction normally used with stationary type burners of the so-called "dry" type; and being

Figure 12 — The control and instrument panel board for the furnace in which most of the experimental work was conducted is shown in this photograph.



supported on the furnace binding independent of the refractories it lends itself readily to maintenance and repair.

The burner is adaptable to and is currently being used on all the types of fuel described in this discussion.

Performance records on our 100-ton furnaces in our No. 1 shop are shown in Figure 7 on fuel consumption, production and refractory consumption from 1943 to date.

Figures 8 and 9 show the burner assembly inside one of our 175-ton furnaces.

Figure 10 shows the flame temperature mounting on the furnace and Figure 11 a typical flame temperature chart.

Figure 12 shows the control and instrument panel of the furnace on which most of the experimental work was conducted.

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DISCUSSION

PRESENTED BY

H. C. REESE, Fuel Engineer, Wheeling Steel Corporation, Steubenville, Ohio

A. J. FISHER, Assistant Chief Engineer of Construction, Bethlehem Steel Company, Bethlehem, Pennsylvania

E. T. W. BAILEY, Combustion Engineer, Steel Company of Canada, Ltd., Hamilton Works, Hamilton, Ontario, Canada

H. V. FLAGG, Combustion Engineer, American Rolling Mill Company, Middletown, Ohio

F. S. SWANEY, JR., Assistant Combustion Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

J. M. BRASHEAR, Assistant Superintendent, No. 2 Open Hearth Department, Inland Steel Company, East Chicago, Indiana

H. C. Reese: The open hearth furnace presents far more problems in combustion practice than any other type of industrial furnace.

In regard to fuel-air ratio, some shops have been experimenting with fuel-air ratio controllers for open hearth work. This has a certain inherent drawback inasmuch as the metered air amounts to as low as 55 to 60 per cent of the total air required for combustion in some shops. In our shop, we use air-flow control and find it desirable to check our combustion at least once a week.

The multiple fuel burner which Mr. Brashear described appears to lend itself well to present day operating demands. The use of oxygen is becoming more widespread than ever.

A. J. Fisher: I would like to re-emphasize some of the points Mr. Brashear brought out with respect to the necessity of compensating for various kinds of fuel oil that most of us are getting these days. We, at Sparrows Point, receive our oil by tankers, in lots of 100,000 barrels or more, and in viscosity that varies from 10 up to almost 200 seconds.

With a uniform practice in burners and atomization, there is quite a difference in the flame radiation and there is also a marked difference in the production of the furnace with these varying oils. We have divided the kinds of oil up into four grades ranging from 10 viscosity up to 200, in which the temperature of the oil varies from 100 to 200 F, in which the steam temperature is varied from 400 to 500 F, and in which the steam flow is varied in terms of pressure on the burner from 80 to 120 psi maximum for maximum fuel flow. This has been brought about by a study of the flame radiation and the effect of the flame on the furnace itself. It shows a need for the development of burners that will compensate in atomization for these various kinds of oils.

We recently installed flame radiation tubes in the roof of one of our new furnaces, this one being much longer than the one Mr. Brashear has shown you. If the furnace had been shorter, we probably could have applied the tubes the same way Mr. Brashear has done. By having the tubes in this place we will be able to study the flame and make compensations for the various kinds of fuel oils as they come to us.

E. T. W. Bailey: I was particularly struck with the author's reference to steam volume. I think it is a truism that many of us overlook the fact that the chief constituent of the volume emerging from the burner tube into the open hearth furnace is steam. A typical example shows that the ratio of oil to steam is something of the order of 1:117. The actual volume of the oil is therefore relatively small and this shows why steam can have a great bearing on the type of flame.

I would like to ask Mr. Brashear what are the maximum ranges of this burner? In other words can you burn all coke oven gas as well as all oil to meet maximum furnace requirements? If not, what would be the limits?

I agree entirely with the author's contention that one cannot very well control the fuel-air ratio to an open-hearth furnace from the analysis of oxygen in the flue gases. We combustion men must not forget that the open-hearth furnace not only heats but refines in a chemical and metallurgical sense.

H. V. Flagg: I can subscribe heartily to the discussion of the variables affecting heat transfer and an open-hearth furnace as given us by Mr. Brashear in his excellent paper. Considered from the standpoint of efficient combustion development as we think of it, for example, when applying nozzle-mix burners with natural gas to an annealing furnace or to a melting pot,

the typical open-hearth burner is the height of inefficiency! The problem in the open hearth is to tailor a body of flame which will transfer heat rapidly and evenly over a large area under conditions which approach both the flame temperature limitation of the fuel and destruction temperatures of the refractories. We all realize, that any deviation from the various conditions established to develop such a heat transfer body such as those enumerated by Mr. Brashear, will have a marginal effect on melting performance which may be out of all proportion to the magnitude of the deviation. Fluctuations in fuel-air ratio, air preheat temperature, atomizing steam, or fuel condition, will affect flame temperature development, while fluctuations in furnace pressure will change the heat losses in the gases leaving the furnace, either or both of which may have a critical effect on melting performance. It is desirable, therefore, that the critical items of fuel flow, air flow, steam temperature and supply, and furnace draft, be so organized and maintained that the most effective settings can be established and so that deviations can be easily and quickly discovered. Flow controllers for oil and combustion air, meters for oil, air, and steam, and a furnace pressure recorder are all requisite to such a combustion system.

Since oxygen content is the only independent variable in open hearth gases, a record of oxygen content would be highly desirable. Unfortunately the oxygen determination must be made on flue gases immediately after they leave the hearth in order to be free from contamination from infiltrated air. Several attempts to make use of the oxygen content have failed because of the difficulty of collecting samples under the conditions of temperature and pressure prevailing at the end of the furnace.

With respect to viscosity control, I would like to ask Mr. Brashear what fuel oil temperatures are required to maintain viscosity within the range of 130 to 135 seconds? With the range of fuel oils that most plants are called upon to use, I would expect that considerable flexibility would be required.

I could well agree that carrying atomizing steam temperatures above 550 F would cause more trouble than the benefit would be worth, but our own experience has been that preheating of steam from the plant conditions of 175 psi gage to 550 F has had a decidedly beneficial effect, due to the double effect that the oil-steam jet is hotter and that a smaller weight of steam is required for a given atomizer steam opening so that the steam consumption is lower.

I would also like to ask Mr. Brashear how the tie-up of steam rate with fuel oil rate is organized and regulated? Some of our first helpers always reduce steam when they cut oil while others do not bother to make any change.

F. S. Swaney, Jr.: Mr. Brashear has presented a very clear picture of pressure conditions existing in the furnace system and the why and wherefore of pressure variations. We have quite a few pressure control installations such as Mr. Brashear has described and these are usually set to give a slight "sting out" at the last or outgoing door. I was very interested in the statement that "uniform furnace pressures are not desirable throughout the entire heat cycle" and wondered if Mr. Brashear would care to amplify this statement? I am sure that we would also enjoy hearing anything more Mr. Brashear may have to tell us on the effects of preheat air temperature on flame characteristics, and, also the technique he employed to determine preheat air temperature.

The problems encountered when attempting to proportion fuel and air by supply control are both manifold in number and difficult in solution. Even control from waste gas analysis would be of doubtful success if applied to the tilting type furnace such as make up about half our number of open-hearth furnaces, and about 75 per cent of our ingot tonnage.

Mr. Brashear's company seems to have solved its problem of burning fuel oils of varying viscosities very nicely by means of their central oil heating plant. Most of our furnaces are fired with our own by-product residual tar, the viscosity, of which we have found to vary very little. This has permitted us to use reheaters at each furnace to control viscosity — these controls usually being set at 270 to 280 F, which gives us a viscosity of about 100–120 SUS. We believe that the use of individual furnace reheaters enables us to realize a slight savings over the central heating plan due to the fact that we are heating just the tar actually consumed instead of maintaining the whole circulating line at atomizing temperature.

One shop of our smaller furnaces is equipped with furnace stack steam superheaters which yield atomizing steam temperatures up to 650 F, but to no discernable advantage. Plants are underway at the present time for a trial of high temperature steam on one of our larger furnaces — the additional superheat to be effected by means of a heat exchanger installed in the furnace checkers. The normal atomizing steam temperature on this furnace is about 350 F, saturated. Mr. Brashear has reported no benefits to be derived from steam above 550 F. I would like to hear his opinion on the use of steam between these two temperatures — i.e., between 350 and 550 F.

Our steam/fuel ratio is about 3.0 lb steam per gallon tar, which compares very closely with Mr. Brashear's figures. I might add here that the furnace operators seem to run a little higher than that figure on meltdown — claiming the sharper flame obtained cuts the scrap more readily. Fortunately for our utility costs, the later stages of the heat permit them to reduce the steam flow to obtain a longer, lazier flame and, subsequently, a more even heat release.

About seven years ago, an attempt was made to use coke oven gas as an auxiliary fuel on some of our smaller furnaces. The project was very shortlived, however, due to the need for the gaseous fuel on other heating units, so that our experience with multiple open-hearth burners has been very limited. However, the points brought out in Mr. Brashear's paper may well serve to revive our interest in the subject, particularly as they may point the way for us to more economically utilize our frequent coke oven gas surpluses, which usually occur during week-end mill shutdowns — especially during the summer months.

Before closing, I would like to ask:

1. Do you ever experience any high sulphur heat

troubles which you could attribute to the use of coke oven gas?

2. Do recessed burner tips slag up?

J. M. Brashear: I was quite interested in Mr. Fisher's remarks, especially in the fact that we seem to concur in a good many thoughts. I would like to pay respect to Mr. Fisher at this time for the splendid work that he has done during the past several years in flame radiation work. Certainly he has made a great many of us get up and go to work.

The burner used in experimental work has a capacity of 60,000 cfhr of coke oven gas and 500 gphr of fuel oil or pitch. The burner will handle both fuels in combination in that total volume or any other desired ratio of the two fuels.

Answering Mr. Bailey's question we are a waste or "dump" gas shop. Both shops take the coke oven gas when no other shop in the plant can use it. We do not like to burn it either but we have to use it. The burner commonly employed will use up to about 40 per cent of the total fuel as gas. However, there is only enough gas available to us normally for about 35 per cent of the total fuel as gas.

Mr. Bargman asked the quantity of the steam per gallon of oil. That was stated in the discussion, that is 2.6 to 3.1 lb for fuel oils and 2.9 to 3.3 for pitch. Our pitch is a pitch oil mixture and it is quite difficult to handle.

Mr. Flagg brings up the question of the range of temperatures required for oils of varying viscosities. I believe we are a little more fortunate than a good many of the plants in the eastern district as we only have one supplier of oil. The range of oil that we receive is generally pretty close in A.P.I., varying generally from 12 to 16 and a temperature control ranging between 192 F and 202 F which will usually suffice to maintain or permit the maintenance of uniform viscosities as stated in the discussion.

In respect to the temperature of the steam employed, it was not my intention to imply that we generally use temperatures under 550 F. In the large open hearth shop, all furnaces are equipped with waste heat boilers. The waste heat boilers also have superheaters. The temperature of the steam leaving the boiler is around 500 F to 520 F total temperature, and that is the steam that is employed on the atomizers in that shop. In the No. 1 shop, the smaller and older shop, they are mostly equipped with waste heat boilers. However, they are not equipped with superheaters and we have heat exchangers built into the checker chambers. We strive for a temperature of 525 F to 550 F at that point. I believe we could sum that up by saying we would like to control our steam temperatures at about 550 F.

As far as steam oil ratios are concerned, Mr. Flagg is correct when he states that we do not use them continuously. We have been doing a lot of experimental work with control units. There are a lot of mechanical problems still involved.

The control is of the electric type wherein we employ two proportioning units. The oil is controlled manually and the steam follows the oil. The operator adjusts the oil to suit his demands or desires.

We also have a steam-oil ratio control working a good part of the time in our No. 1 shop, also on an experimental basis. It is an air operated control. It has been doing a little more successful job perhaps than the one just referred to; however, it is a unit with considerably more equipment, and more equipment must be added to it before it will be fully successful.

Referring to Mr. Swaney's question regarding furnace pressure, it is true that uniform furnace pressures are not desirable throughout the entire heat cycle. We must remember that furnace pressure is very much a function of the heat "head" within the furnace. Obviously, when we have a cold charge in the furnace, we have a very much reduced "head" and we have one furnace pressure characteristic. As the melting progresses, we have another. Nearing the refining stage we still have a third cycle. If we were to attempt to employ the same pressure in each of those three portions of the heat cycle, the usual result would be damaged refractories. We did do that for a number of years and I must confess that I was one of the ones who thought that was absolutely essential. Many of us thought that at the time.

In regard to preheated air temperatures, as most of you know it is difficult to measure. We have made practically all of our determinations in the past few years by taking temperatures in the uptakes of the furnace, using a water cooled inspirating type thermocouple.

In respect to the statement of high steam on scrap, I can agree with Mr. Swaney and his operators when they wish to use a higher ratio of steam on scrap meltdown than they do in the refining periods. However, I think if he would study the problem a little bit further, he would find that the addition of steam by volume increases the flare of the flame but it does not increase the temperature. If there are any benefits derived from it, they are derived from the additional coverage within the furnace.

Regarding the next question on the high sulphur content of coke oven gas affecting the bath, our experience can be summed up somewhat in the following manner. Melt sulphurs generally do show from 1 to 3 points higher, but strangely enough, tapping sulphurs show little if any difference. We have also found this to be true when studying the effects of 2.0 to 2.5 per cent sulphur content oils.

Mr. Swaney's next question was on the burner tips. We do have trouble with the burner tip slagging up. That was one of the purposes for introducing the seamless tube around the burner rather than applying the back pressure steam down through the burner. In that respect, we find that a smaller amount of steam will do the same work. Since we put those tubes on, we have reduced the need for burner cleaning materially. It is not unusual for us to go for several days without any difficulty with the burner. Prior to that, we were cleaning them daily.

The last question, from Mr. Rahilly I believe, was with the flame velocity and high steam. I think that is a comparable question to the one I just referred to with the high steam on the scrap. If you increase the volume of the steam, obviously you increase your overall burner velocity, but you do not get the benefits from the high velocity flame that you would naturally expect. You get too much of a flare in the flame.

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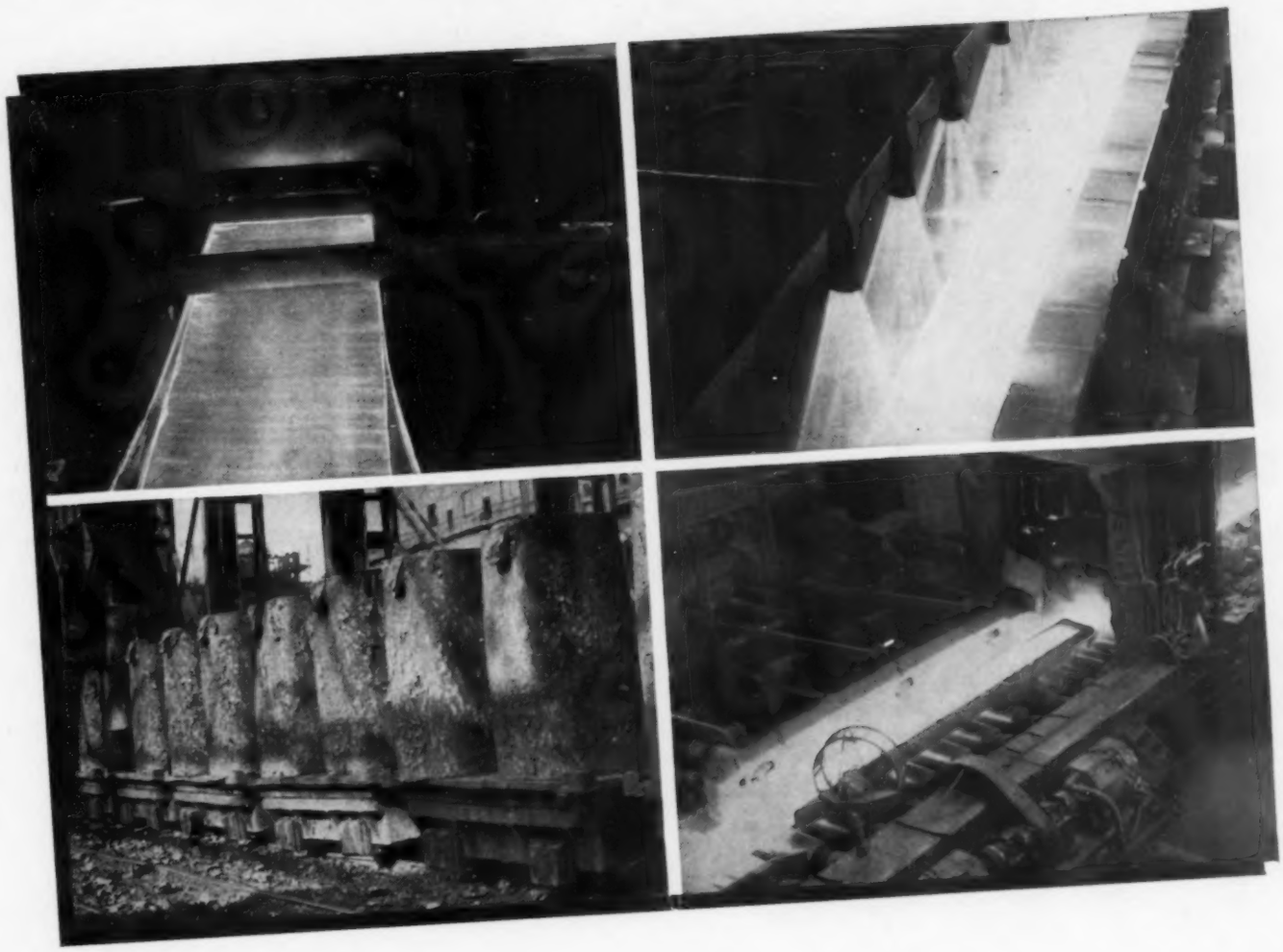

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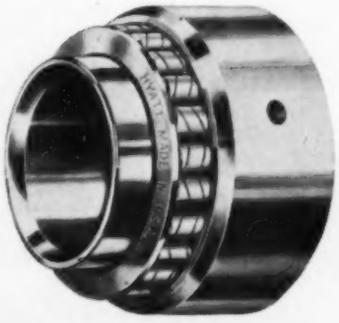

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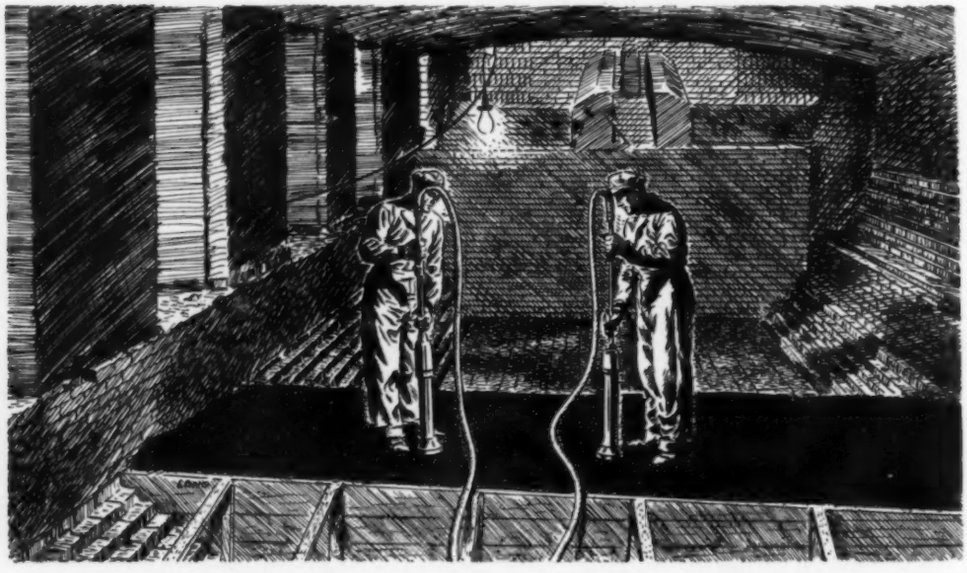

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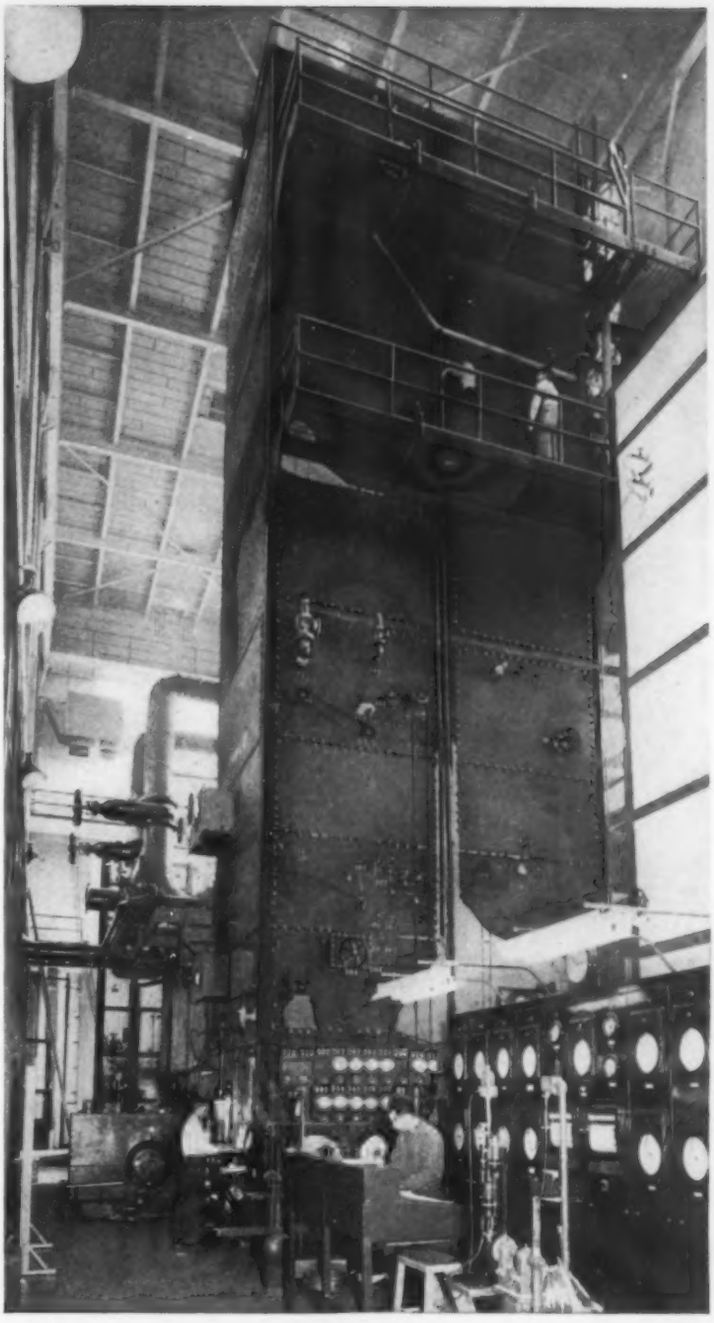

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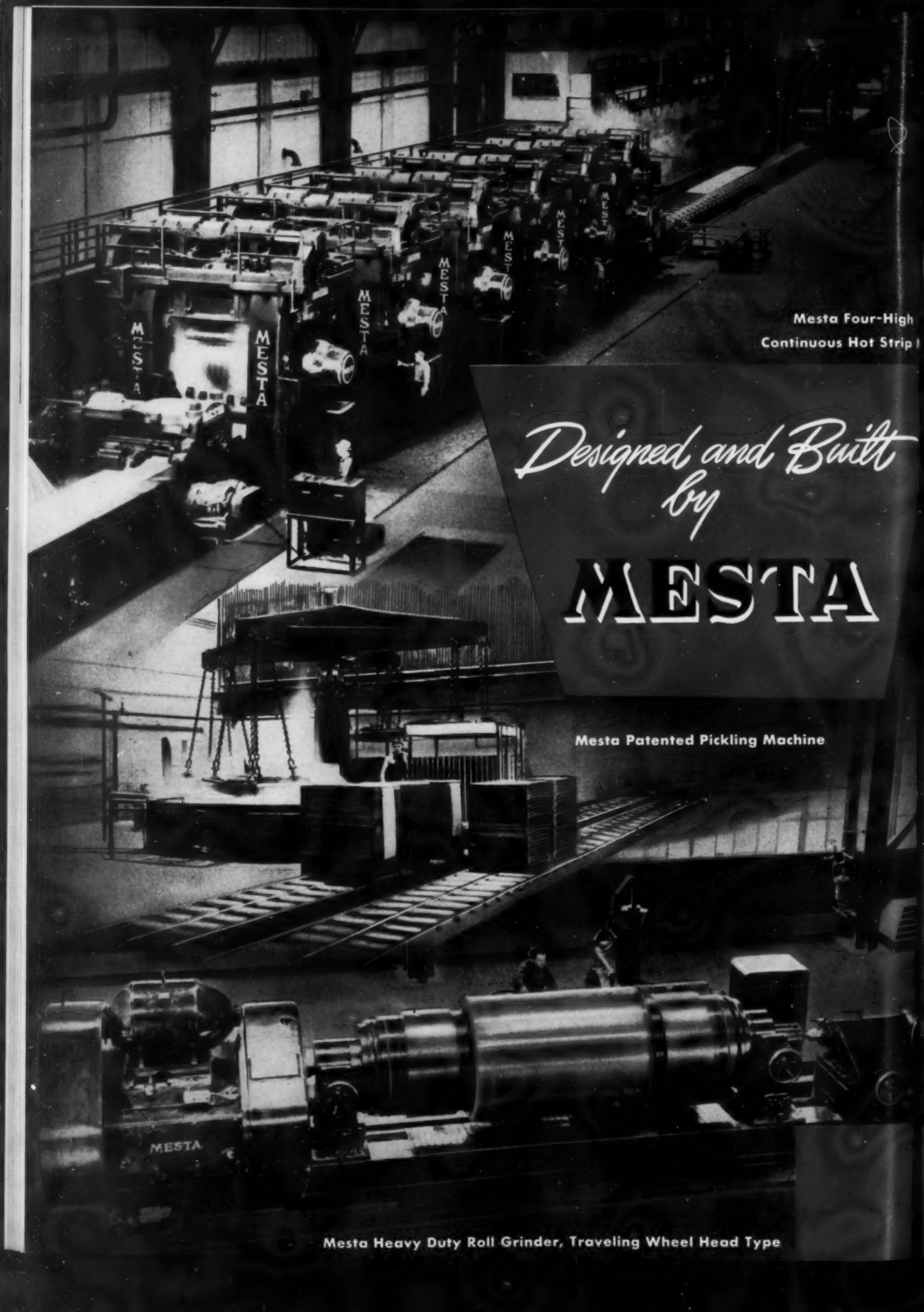

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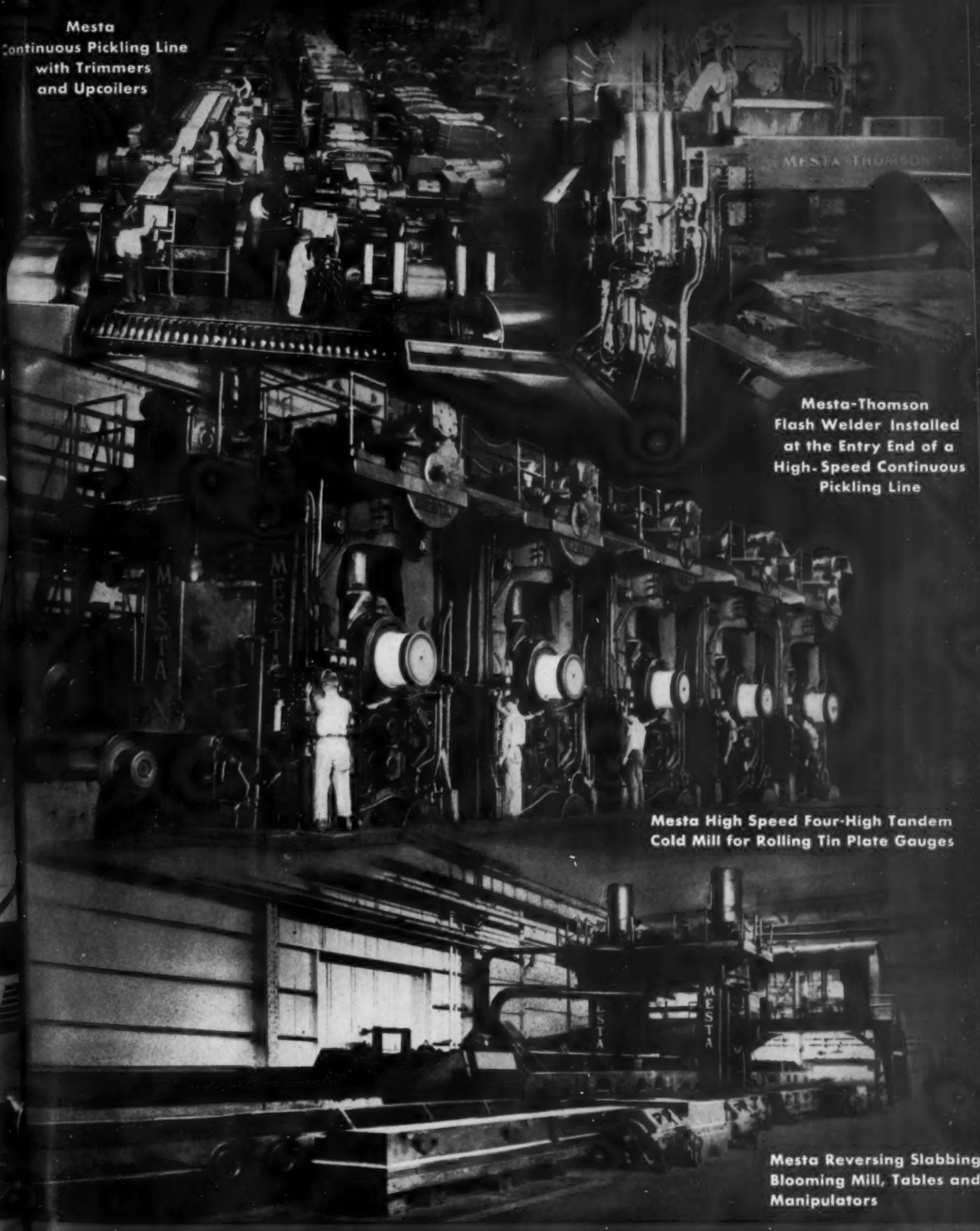

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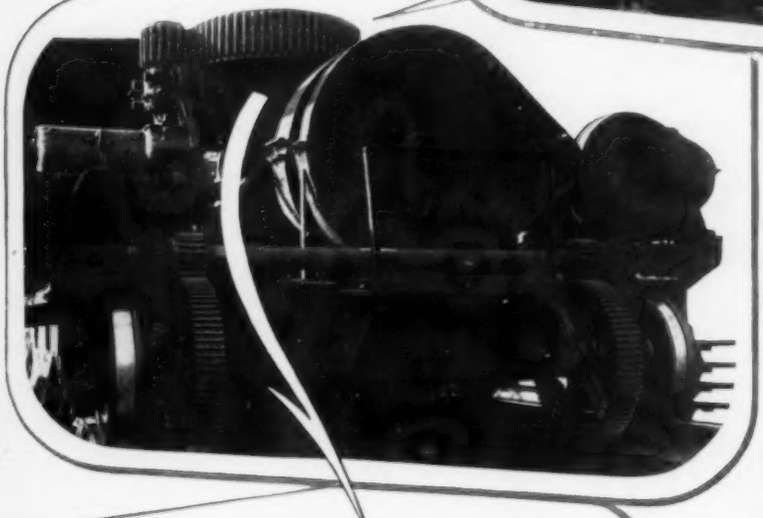

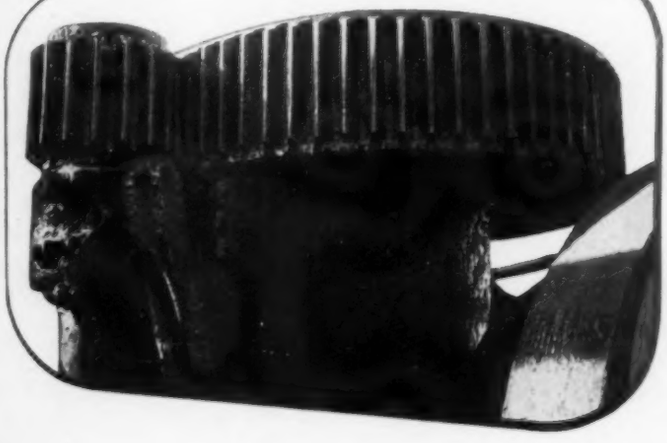

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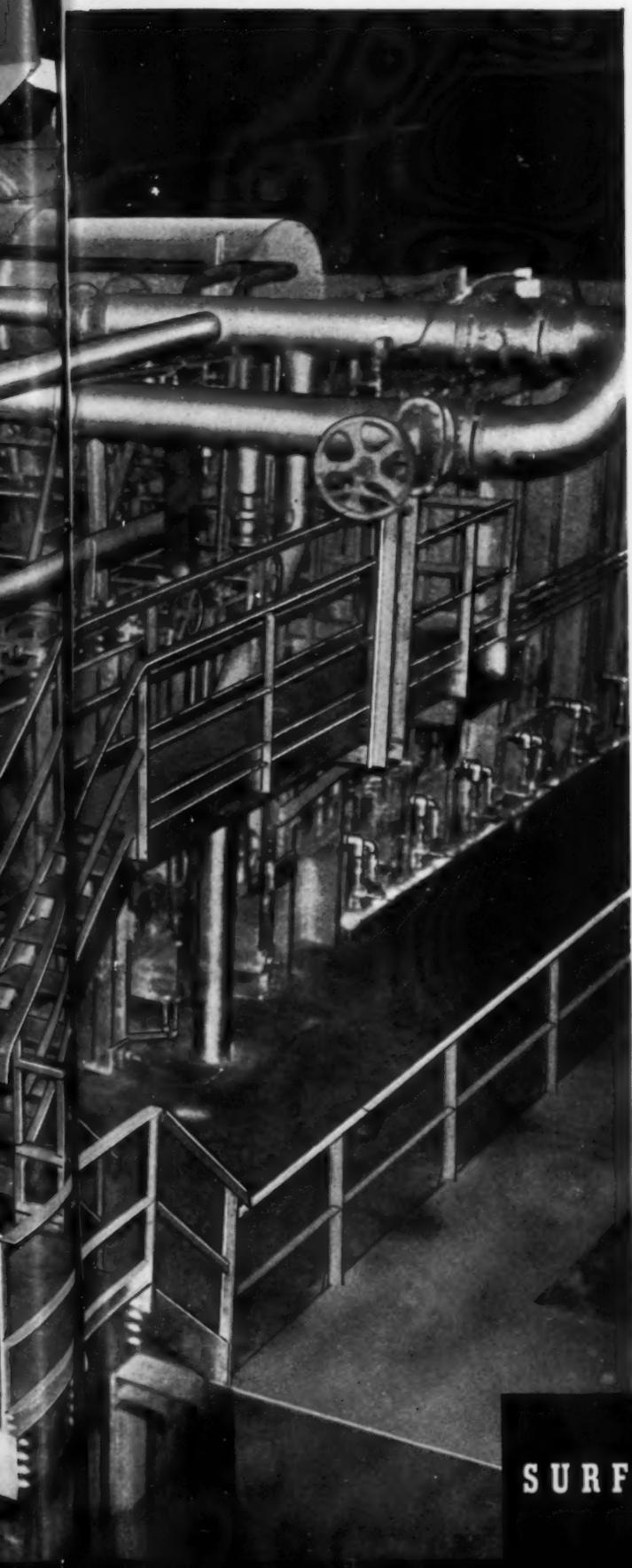

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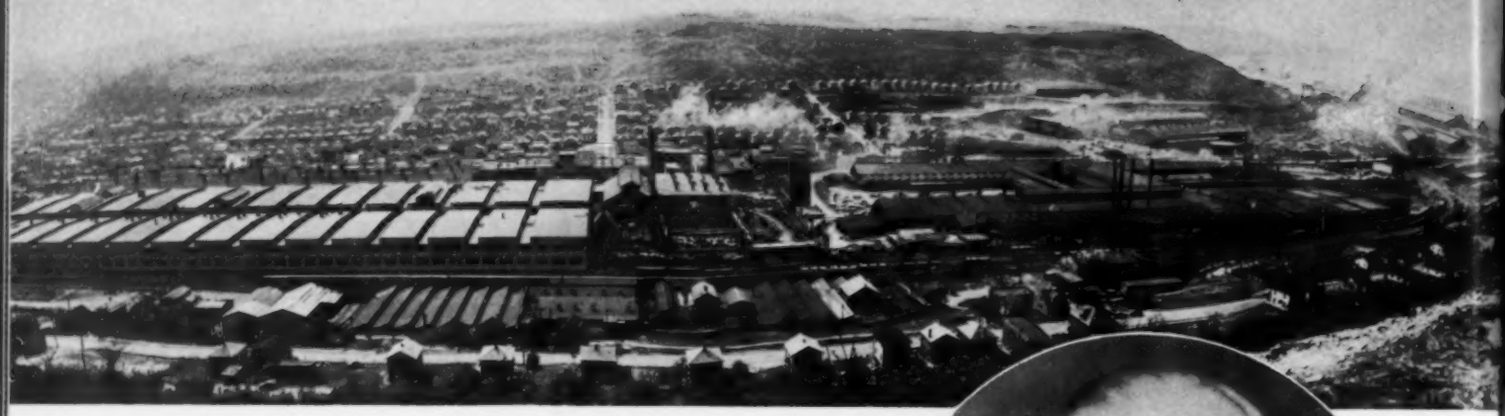
Weirton Steel Company... by T. J. Ess



. . . . the rapid growth and constant development of Weirton Steel Company mirrors the driving energy of its guiding spirit, E. T. Weir, and of the able organization he has built around him . . . . the past 43 years have witnessed the parallel evolution of the company and its founder from modest beginnings to dominant positions in the iron and steel industry . . .

E. T. WEIR
Chairman

▲

T. E. MILLSOP
President

▲ WEIRTON Steel Company, a major unit of National Steel Corporation and the country's largest independent producer of tin plate, had its origin in 1905, with the purchase of a little tin plate plant at Clarksburg, West Virginia. This unit, which consisted of eight hot mill stands, was organized under the name of Phillips Sheet and Tin Plate Company. By 1908 four more hot mills were installed, and in 1909 the present site of Weirton was selected for the construction of a new plant.

A ten-mill tin plate plant was quickly put into operation at Weirton, and ten more mills added in 1911. In

Six batteries of by-product coke ovens, totaling 262 ovens, amply supply all coke requirements. Approximately 5000 tons of coal can be carbonized per day.

1912, the Steubenville plant of Pope Tin Plate Company was purchased, adding 12 mills to the company's total.

By 1915 the company had 50 hot mills as well as a cold-rolled strip steel plant. By 1918, two narrow hot strip mills had been installed, and in that year the name of the organization was changed to Weirton Steel Company.

In 1919, a 600-ton blast furnace was put into operation, to be followed over the next two years by six 100-ton open hearth furnaces, a 40 in. blooming mill, and 21 in. and 18 in. billet and bar mills. Extensive reserves of iron ore, coal and limestone were also acquired at that time. In 1923 a complete sheet mill was added for hot and cold rolling, annealing, pickling and galvanizing. One battery of by-product coke ovens was also completed, as well as a sintering plant.

Another large expansion project was carried out between 1926 and 1928, when a second battery of coke ovens, an 800-ton blast furnace, five more open hearth furnaces, and a 48-in. continuous strip mill were built. River docks were also rebuilt and enlarged. In 1930, one 400-ton open hearth furnace was installed, making a total of 12 furnaces.

Subsequent major expansions include the installation of a structural mill, the construction of additional coke ovens, and the gradual enlargement of open hearth and blast furnaces. During the recent war years, a third large blast furnace and two new batteries of coke ovens were added. Postwar expansion has continued apace, marked by further enlargement of blast furnaces, rebuilding of the hot strip mill, expansion of cold reduction and finishing facilities, and embarkation on a project for the use of oxygen in open hearth and blast furnaces to increase production.

Constantly accompanying the major expansions were never-ending programs of development and improvement which have kept Weirton's equipment and operations among the most efficient and economical in the industry.

The result of the pioneering enterprise sketched briefly in the foregoing is the modern, integrated plant at Weirton, lying in an arc-shaped valley tipped at each end by the Ohio River. At the upper intersection are the river docks, coke ovens and tin mill, followed by the blast furnaces, open hearth, blooming mill, and billet, bar, structural, sheet, and strip mills.

The plant includes facilities for the production of 1,400,000 tons of by-product coke, 1,240,000 tons of pig iron, and 1,950,000 tons of steel ingots per year. Rolled steel products include heavy structural shapes and piling, splice bars, tie plates, track spikes, hot rolled bars, chemically treated black plate, tin and terne plate (both hot dipped and electro plated), hot and cold rolled strip, and hot rolled, cold rolled, galvanized and long terne sheets.

COKE PLANT

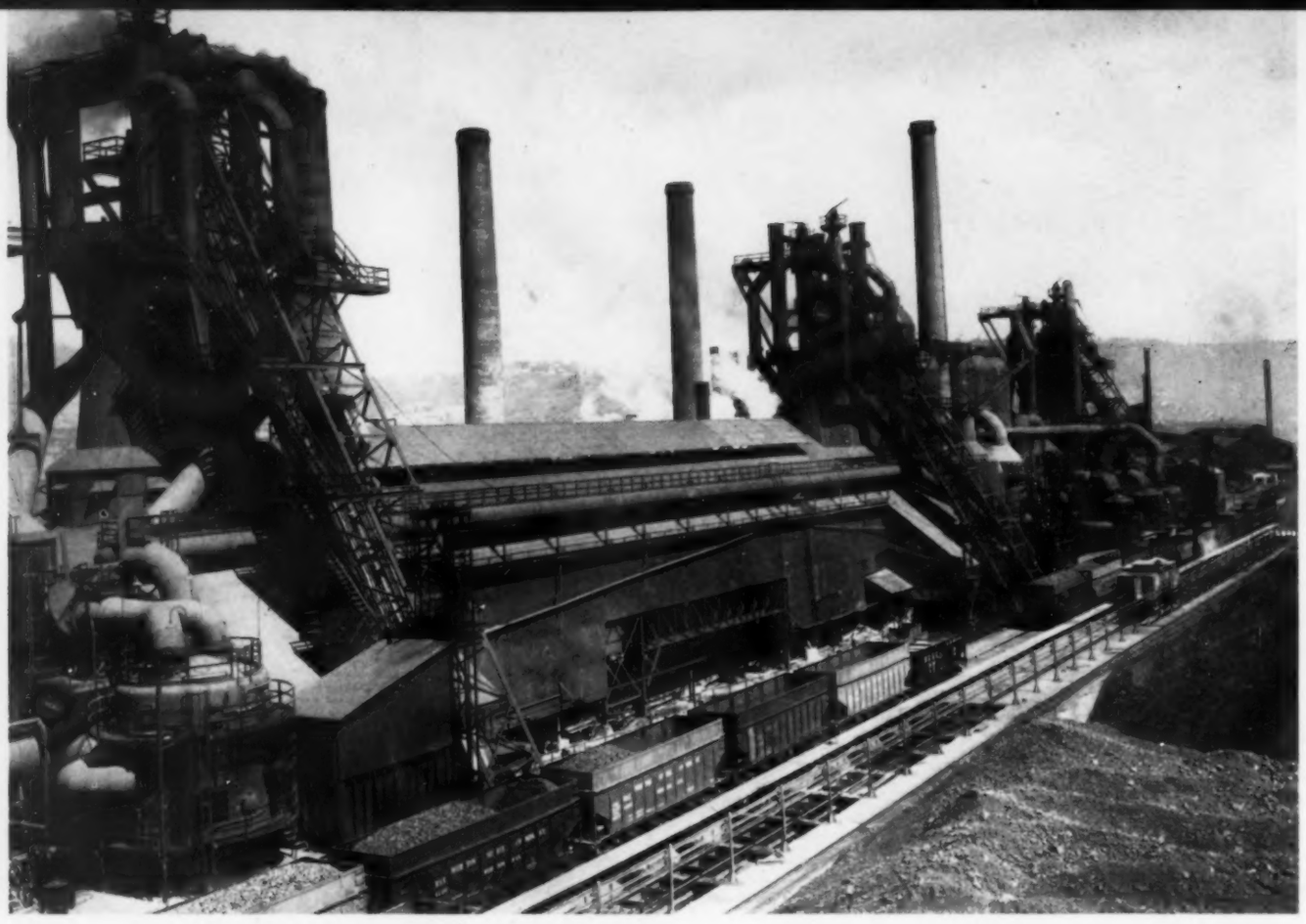
Coal comes to Weirton principally from the company's own mines located at Isabella in Fayette County, Pennsylvania. After being washed, the coal is transported by rail to Weirton or loaded into barges on the Monongahela River for river shipment to Weirton. Coal analyses show averages of 7.5 per cent ash, 1.4 per cent sulphur, and 35.5 per cent volatile matter.

At Isabella, there are also 136 beehive coke ovens, each 34 ft 9 in. long × 5 ft wide and capable of taking a coal charge of 10–12 tons of coal. These ovens are used only in times of peak demand, when coke is supplied to various subsidiary companies.

Arriving at the Weirton plant, coal is unloaded, by a tower hoist capable of handling up to 500 tons per hour, into a bin which feeds a belt conveyor leading to a breaker building, from where the coal may pass to the mixer building for immediate use in the ovens or to a storage yard. This yard is served by a whirley boom of 100 ft radius, aided by bulldozers.

Belt conveyors carry the coal from the breaker building to the mixer building and then on to the oven bins. Coal charged to the ovens is 100 per cent high volatile, crushed so that 50 per cent passes through a $\frac{1}{8}$ in. mesh.

A total of 262 coke ovens, arranged in six batteries, provide coking capacity for approximately 5000 tons of coal per day. Three of these batteries, consisting respectively of 37, 49 and 25 ovens, have ovens $13\frac{1}{4}$ in. and $14\frac{3}{4}$ in. wide, $12\frac{1}{2}$ ft high and 40 ft long, which take a coal charge of 14 tons. These batteries are of the gun flue type, and are underfired with coke oven gas.



The three blast furnaces have hearths 25 ft 6 in. in diameter, and provide a total annual capacity for 1,240,000 net tons of iron.

In the three newer batteries, which contain 45, 53 and 53 ovens, respectively, the ovens are 15½ in. and 18½ in. wide, and 13 ft high, and take a coal charge of 17 tons per oven. These three batteries are of the underjet type, and are heated by blast furnace gas with enriching jets of coke oven gas.

Four of these batteries are located in one line, while the two newest batteries form another line at an angle to the others.

Coal and coke handling systems follow the conventional pattern, and by-product equipment is provided for the recovery of the usual benzol, xylol and toluol products, as well as tar and ammonium sulphate. By-product yields per ton of coal average about 12,000 cu ft of gas, 3.2 gal of light oil, 11.5 gal of tar, and 23 lb of ammonium sulphate. Sodium phenolate is also recovered. Surplus gas is burned in the various heating operations in the steel plant.

Located near the coal mixer building is a test oven in which coals may be tested to ascertain their coking characteristics.

BLAST FURNACES

Coke from the screening station is moved in transfer cars to the coke bins under the blast furnace high line.

Iron ore is supplied from company-owned mines in the Mesabi and Old Range fields. The ore is graded at the head of the lakes, and manganese ore is sintered there. Ore is received at the plant by rail from the lower lake ports, and the cars may be taken directly to the high line above the blast furnace stock bins, or to the ore yard, where the ore is unloaded and stocked by car dumper and ore bridges. The ore yard is approximately 240 ft wide × 1200 ft long, and is served by two 10-ton bridges. Limestone is also stocked here.

From the blast furnace stock bins, ore and stone are conveyed to the skip cars by 15-ton scale cars. Coke is discharged from stock bin directly into the skip cars, is screened in the process.

Pig iron is produced in three blast furnaces of modern design which provide a total capacity for 1,240,000 net tons of iron per year. Dimensional data for these furnaces are as given in Table I. In all of the furnaces, hearth and bosh cooling is provided by 12 rows of copper cooling plates. Water cooling is carried up past the bosh with nine rows of plates. Cast iron wearing plates set into the lining protect the stock line section.

Each furnace is charged by a conventional double skip dumping into a rotating distributor top. Bells are operated through levers and cables by pneumatic cylinders. The usual charging sequence is ore, ore, stone, coke, coke. Ore and stone are charged by weight, while coke is charged by volume, except on No. 3 furnace, where an automatic weighing hopper is used in connection with a complete automatic filling control. Normal burdens contain 1.92–1.94 lb of ore per lb of coke, and approximately 3.6 lb of ore per lb of limestone. Silica in the ore mix averages about 8.75 per cent.

Normal blast volume to the furnaces ranges 68,000–73,000 cfm, and is supplied from three of four turbo-

blowers, two rated at 65,000 cfm, 25 psi, and two at 84,000 cfm, 25 psi. All of these units are equipped with barometric condensers.

Blast to the furnaces is heated in stoves as listed in Table I. Checker-work in the stoves for No. 1 and 2 furnaces is formed of standard checker brick, with inserts and fillers in 4 in. × 4 in. flues. The stoves of No. 3 furnace have 5¼ in. × 5¼ in. flues, formed of checker tile and containing inserts and fillers. Pressure burners automatically proportion the blast furnace gas and air used to heat the stoves. Approximately 20 per cent of the total gas make is consumed in the stoves. Blast temperatures average 1045–1150F, with peaks of 1200–1400F. Automatic mixing controls regulate temperature of the blast to each furnace.

Furnace top pressure is usually 50–60 in. water column, and top temperature ranges 290–315F. Gas leaves the furnace top through four 5 ft 6 in. offtakes in each large bell cone, and is led through a dust catcher, a whirler, and a wet washing tower. The first two units clean the gas to a dust content of about 3 grains per cu ft, while the wet washer reduces this to approximately 0.13 grains per cu ft. Gas to be used in the stoves and boilers then passes through five electric precipitators, while that to be used in coke ovens and soaking pits passes through three disintegrators. The fine cleaned gas has a dust content of less than 0.01 grains per cu ft. A 1,000,000 cu ft gas holder is provided on the blast furnace gas system supplying gas for coke oven heating.

Flue dust averages 195 lb per ton of iron. This is processed in a 42 in. × 25 ft 6 in. sintering plant having a rated capacity of 175 tons per day.

Iron is produced principally for use in the open hearth, with analyses averaging about as follows:

	Per cent
Silicon	1.18
Sulphur	0.035
Phosphorus	0.381
Manganese	1.10
Carbon	4.45

The iron is tapped into open top ladles of 65 tons capacity, and shifted to the mixer in the open hearth building. A two-strand pig machine is provided for iron that is not to be used hot.

Approximately 1080 lb of slag is made per ton of iron. Slag from one furnace can run directly into an adjacent granulating pit. Normally all slag from the furnaces is hauled to a hot slag dump, where it is subsequently processed by an outside company.

Slag analyses average about as follows:

	Per cent
SiO_2	34.58
Al_2O_3	12.84
CaO	42.73
MgO	7.37
S	2.32
Fe	0.18
Mn	0.45

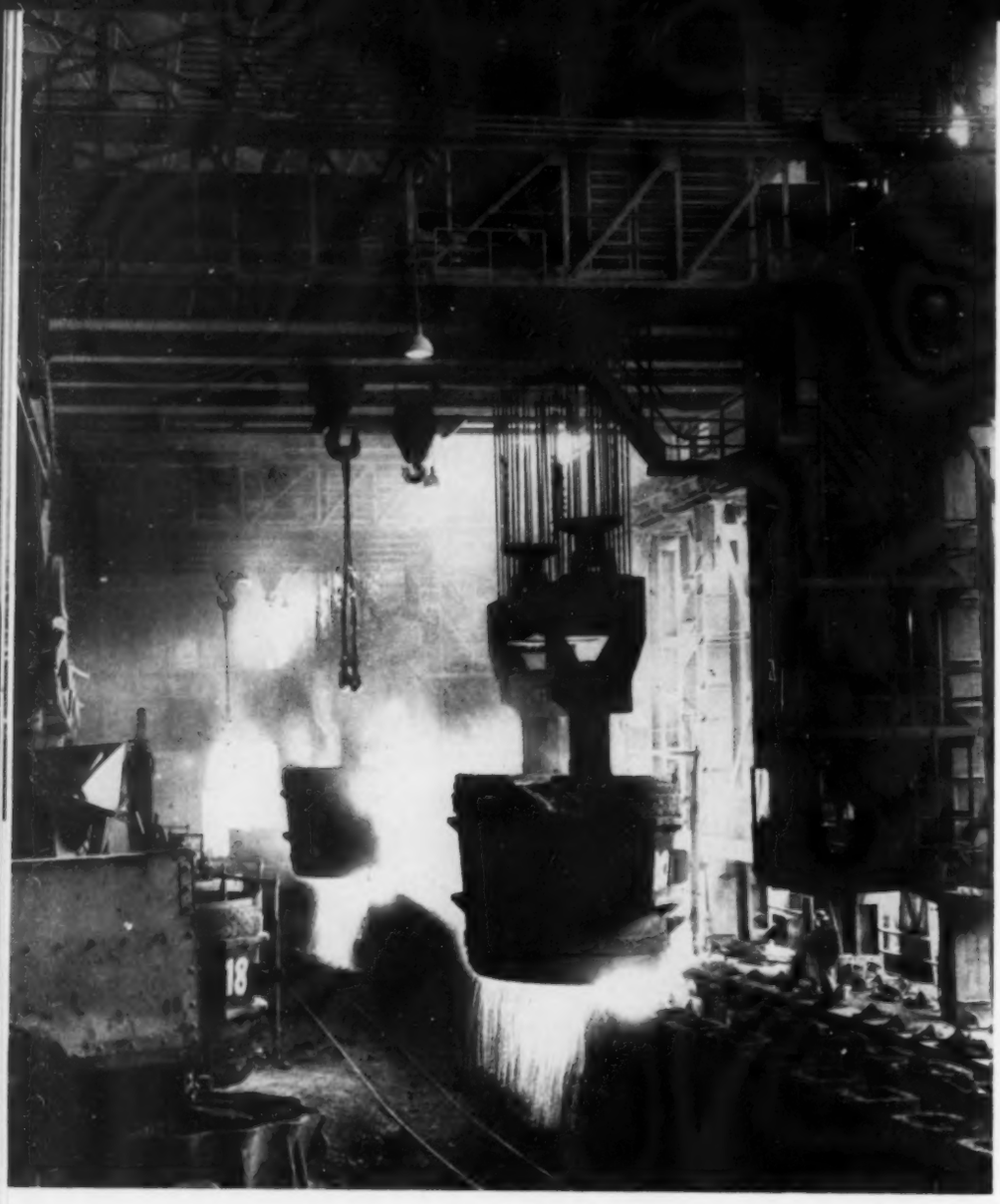
OPEN HEARTH

Hot metal from the blast furnaces is weighed as it is brought to a 1300-ton mixer located at one end of the open hearth shop. The iron ladles are raised by crane and emptied into the mixer. Iron is poured out of the

TABLE I

Blast Furnace Proportions

Description	Furnace number 1	Furnace number 2	Furnace number 3
Diameter of hearth, ft-in.	25-6	25-6	25-6
Diameter of bosh, ft-in.	28-6	28-6	28-6
Diameter of stockline, ft-in.	19-4	19-4	19-6
Height of crucible, ft-in.	12-0	13-3	12-0
Height of bosh, ft-in.	11-0	11-0	11-0
Height of straight section, ft-in.	2-6	2-6	7-3
Height of inwall section, ft-in.	53-3	53-3	54-0
Height of stockline section, ft-in.	8-3	8-3	9-0
Height, iron notch to top ring, ft-in.	91-6	92-0	100-0
Height, bottom to iron notch, ft-in.	2-3	3-6	2-3
Height, iron notch to cinder notch, ft-in.	4-8	4-8	4-8
Height, cinder notch to tuyeres, ft-in.	3-4	3-4	3-4
Bosh angle, deg-min	82-14	82-14	82-14
Inwall batter, in. per ft	1 1/32	1 1/32	1
Stack volume, cu ft	39,347	39,347	43,740
Number of tuyeres	16	16	16
Number of columns	16	16	16
Diameter of large bell, ft-in.	14-2	14-2	14-6
Angle of large bell, degrees	52	52	52
Thickness of crucible lining, in.	31½	31½	31½
Thickness of bosh lining, in.	27	27	27
Thickness of stack lining, in.	54	54	54
Thickness of throat lining, in.	45	46	45
Number of hot blast stoves	4	3	3
Height of stoves, ft	100	118	110
Diameter of stoves, ft	(3) 22 (1) 25	25	26
Heating surface per stove, sq ft	(3)123,129 (1)158,349	193,439	211,070



Steel is poured into ingots of various sizes, according to the type of steel and its ultimate use. Two new ladle cranes were installed recently to handle the larger heats resulting from furnace enlargement.

mixer into ladles on the charging floor level. These ladles are then weighed and moved by electric locomotive to the desired furnace.

Basic open hearth steel is produced in 12 furnaces, six of 200-ton capacity five of 380-ton capacity, and one of 400-ton capacity. Hearth dimensions of the 200-ton furnaces are 16 ft × 44 ft 9 in., while those of the larger furnaces are 19 ft × 48 ft. Furnace roofs are of sprung arch construction, 15 in. thick with 21 in. rings, and refractory application follows conventional practice. Furnace bottoms are of rammed refractory type. Checkerwork on each end of the furnaces totals approximately 8200 cu ft on the smaller furnaces, and 11,800 cu ft on the large furnaces.

The furnaces are fired with fuel oil, and fuel consumption averages about 3,000,000 btu per net ton of ingots. Oil is received principally in river barges, from where it is pumped into three storage tanks totaling 2,250,000 gal capacity. Oil flowing from the 275 psi recirculating system to the burners is automatically maintained at a temperature of 200F.

Each furnace is equipped with a waste heat boiler. Seven of these are rated at 600 hp, and five at 900 hp.

Furnace charges may consist of 40–45 per cent hot metal and 60–55 per cent of heavy and light scrap. As a substitute for scrap, a considerable amount (up to 70 per cent of the furnace charge) of blown metal is also used. This metal, with analyses averaging 1.5 per cent carbon, 0.30–0.50 per cent manganese, 0.038 per cent sulphur, and 0.05 per cent silicon, is produced in two 25-ton converters located in the mixer building. Blast is furnished to the converters from a 45,000 cfm engine-driven blower or a 65,000 cfm turboblower.

At present, scrap-hot metal charges are used in the 200-ton furnaces, while blown metal charges are used in the larger furnaces. Time of heat in both cases averages about 14¾ hr, tap to tap. Under comparable conditions, the use of blown metal charges reduces the time of heat by about 30 per cent.

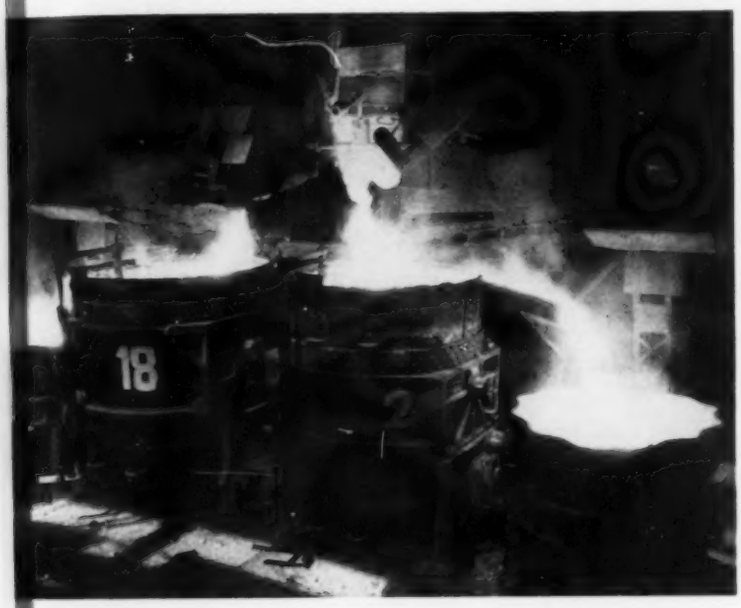
Flux consumption runs approximately 125 lb per ton of ingots, and about 11 lb of ferro manganese and one lb of deoxidizers are used per ton of ingots.

Steel is produced in rimming and killed types, with carbons generally of the order of 0.08–0.10 per cent. It is tapped into 200-ton ladles, two ladles being used for heats from the large furnaces.

Steel is poured direct into ingots of various sizes, according to the type of steel and its ultimate use. Ingots range from 25 in. × 27 in. (12,100 lb) up to 22 in. × 51 in. (19,500 lb). Three pouring platforms are provided, and ingot cars are designed to accommodate a double row of molds.

Early in 1946, a four-unit high purity oxygen plant, with a capacity of 100,000 cu ft per day, was put into operation. This plant supplies oxygen for scarfing, welding and burning operations in the steel plant. Some oxygen has also been used experimentally in open hearth furnaces. Approximately 220 cu ft per ton of ingots is put through the oil burner, and 1700 cu ft per ton is used through a ¾ in. bath lance. The experiments have indicated that the time of heat is thus reduced as much as 10 per cent.

Recently, plans were announced for a new oxygen plant of the same general type as the original plant, but with a daily capacity of 400 tons of 93 per cent oxygen. It is planned to use the product from this plant for regular production work in the open hearth furnaces,



Steel is tapped into 200-ton ladles, with two ladles being used for heats from the larger furnaces.

and for experimental work in the converters and blast furnaces.

The open hearth shop consists of four adjacent bays 1083 ft long. The charging bay is 85 ft wide and is served by two 100-ton cranes, one 10-ton crane, and four 7½-ton charging machines. A leanto, 45 ft wide, runs along the back of the charging floor. The pouring bay, 60 ft wide, contains four ladle cranes, two of 175 tons and two of 275-ton capacity. Adjacent to the pouring bay is a mold yard 99 ft wide, containing two 15-ton cranes.

Near this group of buildings is a stockhouse, 840 ft × 103 ft, served by five overhead cranes ranging 10–20 tons in capacity. The width of this building is divided between two levels, the higher being on the same elevation as the open hearth charging floor. Scrap is stored on the lower level of this building, while strings of charging boxes to be filled are run in on tracks on the upper level. Limestone, dolomite, iron ore, etc. are also stocked in bins in this building.

Additional storage is provided by another scrap yard 100 ft wide × 980 ft long, served by one 10-ton crane.

Next to the previously mentioned mold yard, and in direct line with the soaking pit building is a stripper building which contains two 150-ton stripper cranes.

BLOOMING MILL

Ingots are heated in 39 soaking pits, grouped into ten rows. All of these are of regenerative, reversing type, and range 14–18 ft in length, and 6 ft 3 in. — 8 ft 6 in. in width, and are 9 ft deep. They are fired with a mixture of blast furnace gas and coke oven gas with a calorific value of 165 Btu per cu ft. These gases are mixed in a nearby station, which is arranged so that natural gas may be substituted in the mixture in the event of shortage of coke oven gas.

All of the pits are equipped with automatic time reversal control.

Approximately 85 per cent of the ingots are charged hot (about 1200F), while the remainder are cold. Fuel consumption averages 920,000 Btu per ton of ingots.

Ingots are charged into and drawn from the pit furnaces by one pit crane of 15-ton capacity and two of 7½-ton.

An ingot car conveys the heated ingots to the blooming mill approach tables, which total about 112 ft in length.

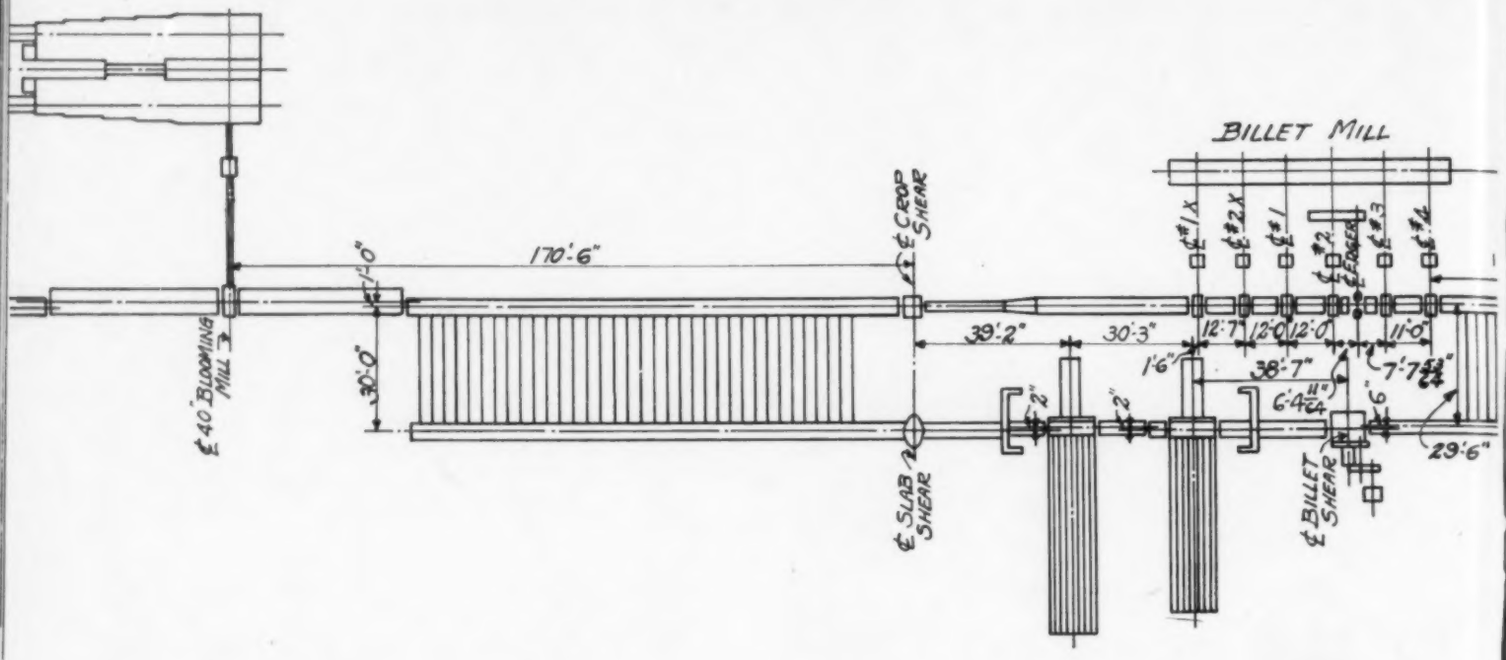
The blooming mill is a 40 in. two-high, reversing unit, driven through 18 in. spindles by a 25,000 hp, 42 in. and 66 in. × 60 in. twin-tandem cross-compound steam engine. The engine operates on 225 psi steam, and exhausts into a barometric condenser at about 27 in. mercury vacuum. A maximum speed of 125 rpm is attained.

Mill pinions are of 40 in. pitch diameter and 7.854 in. circular pitch, and have a 50 in. face.

The engine drive and mill pinions are located in an engine room 54 ft wide located adjacent to the mill building.

Mill rolls are 37 in. in diameter and have a 92 in. body length, carrying grooves of 4, 8 and 13 in., and a 50 in. bullhead. They run in roll neck bearings of

Weirton uses bessemer converters solely to supply molten blown metal for open hearth charges. Two 25-ton converters are installed in the mixer building.



General arrangement of blooming, billet and bar mills.

bronze and babbitt which are lubricated from a central grease system. The top roll is balanced hydraulically by a pressure of 675 psi, and is raised and lowered at speeds of 18–22 fpm by 12 in. screws of 2 in. pitch, driven by two 100-hp mill type motors under magnetic control. A maximum roll lift of 50 in. is available.

Ingots passing through the mill are manipulated by hydraulically operated sideguards and fingers. Front and back tables of the mill attain a speed of 590 fpm.

The 40 in. mill rolls blooms ranging from 8 × 8 in. to 16 × 18 in. in size, and slabs 15–49½ in. wide × 3–5½ in. thick. Mill product runs about 80 per cent slabs and 20 per cent blooms, with rolling rates averaging about 230 tons per hr of slabs and blooms. A monthly record of 182,380 net tons, charged weight, was set on this mill in October, 1947.

In direct line with the blooming mill are the 21 in. and 18 in. bar and billet mills, while paralleling this line, 34 ft to one side, is another table line. Connecting these parallel tables between the bloomer and the 21 in. mill is a transfer 110 ft wide. Material from the blooming mill that is not to be rolled in the bar and billet mills is transferred to the parallel line and proceeds to an 800-ton steam hydraulic shear capable of cutting widths up to 49½ in. The sheared product is then removed over two cooling beds, each approximately 46 ft long × 12 ft wide, into an adjoining slab yard. Crop ends are transported by an inclined conveyor to a convenient crop pit.

BILLET AND BAR MILLS

Material from the blooming mill which is to be rolled in the bar and billet mills proceeds straight ahead to a 300-ton motor-driven crop shear and on to the 21 in. mill. This mill consists of six two-high stands and one edging stand as follows:

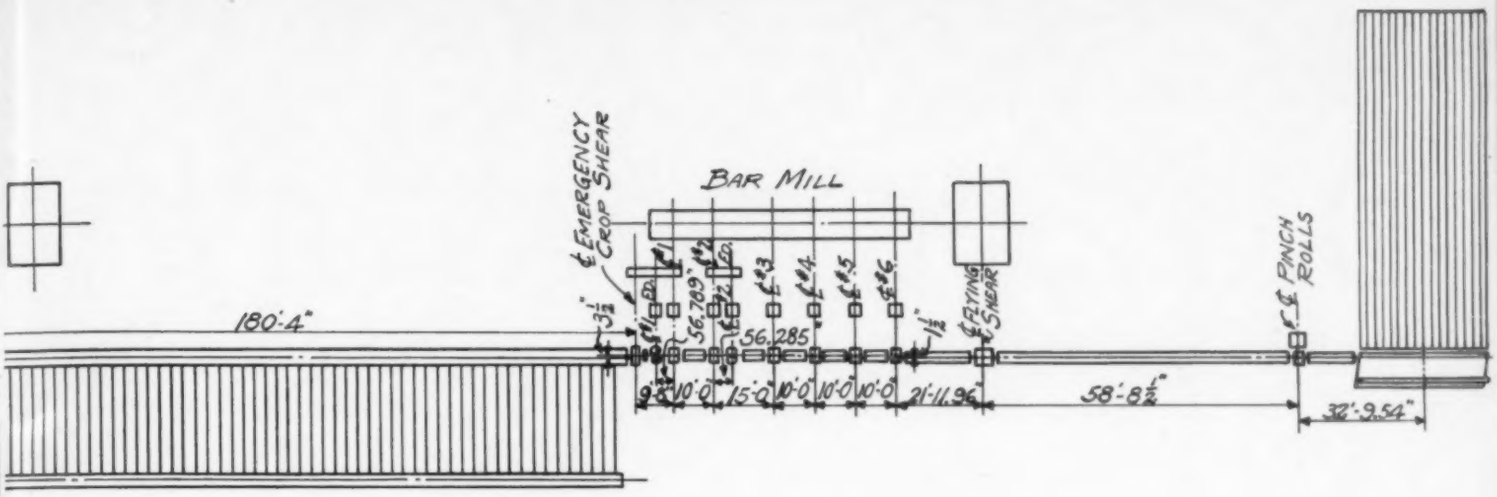
Stand	Nominal size, in.	Distance from preceding stand, ft-in.	Roll rpm
1	24	....	13
2	24	12–8	16.9
3	21	12–0	20.7
4	21	12–0	27.5
Edger	..	6–4	....
5	21	7–8	32.6
6	21	11–0	40.6

This mill is driven through a line shaft and miter gears by a single 4000-hp, 6600-volt, 60-cycle, 76-pole, 93-rpm induction motor.

The 21 in. mill produces bars and billets 4 in. thick × 4–7 in. wide, and 3 in. slabs 6–14 in. wide. Rolling rates range 180–225 tons per hour.

If the section leaving the 21 in. mill is final, the product leaving the mill is taken over a transfer about 165 ft wide to the parallel table line previously mentioned, where it can be taken in either direction. If moved in the direction opposite to that of mill flow, the steel passes through a 600-ton motor-driven billet shear, and on to the cooling conveyors previously mentioned. If proceeding in the same direction as in the mill, the steel passes through a motor-driven shear and on to a push-off and piling cradle.

If the steel leaving the 21 in. mill is to be further reduced, it moves on over roller tables directly to the 18-in. mill, a continuous train of six two-high stands



and two edging stands. These stands are as follows:

Stand	Nominal size, in.	Distance from preceding stand, ft-in.	Roll rpm
Edger	..	....	....
1	18	4–8	25.77
2	18	10–0	33.3
Edger	..	4–8	....
3	18	10–4	48.4
4	18	10–0	67.78
5	18	10–0	94.94
6	18	10–0	127.0

All of these stands are driven through line shaft and miter gears, by one 4000-hp, 6600-volt, 60-cycle, 76-pole, 93-rpm induction motor, a duplicate of the drive on the 21 in. mill. This drive, and that of the 21 in. mill, are located in a motor room which runs along the side of the mill building, and is really an extension of the blooming mill engine house. Here are also located two large roll lathes, as well as transformers and motor-generator sets which supply power for auxiliary equipment.

The 18 in. mill produces squares in a range of 1½–3¼ in., as well as sheet bar 8–13 in. wide and ¼–2 in. thick, at rates of 120–200 tons per hour.

An emergency crop shear is located just ahead of the 18 in. train, and a flying shear is placed 22 ft after the last stand.

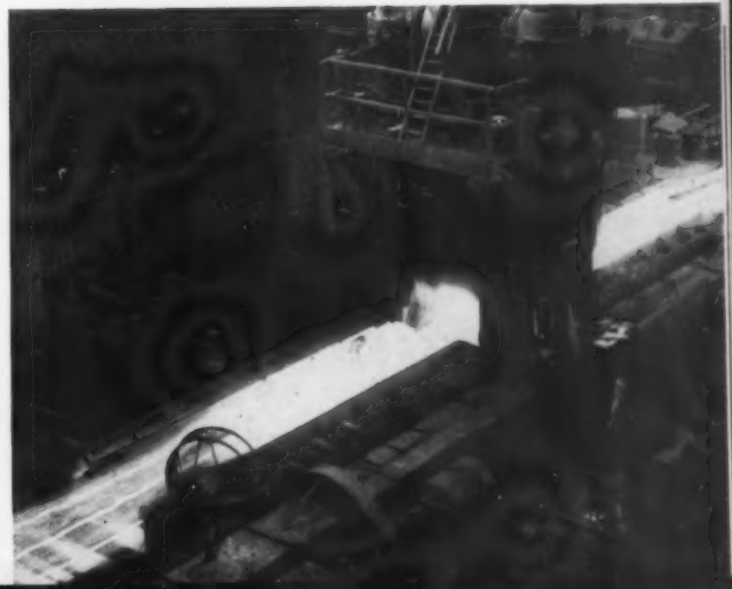
Approximately 65 ft after the flying shear is a cooling bed about 30 ft wide × 84 ft long on one side of the table and a piler on the other side. The rolled product may be routed either way, as desired.

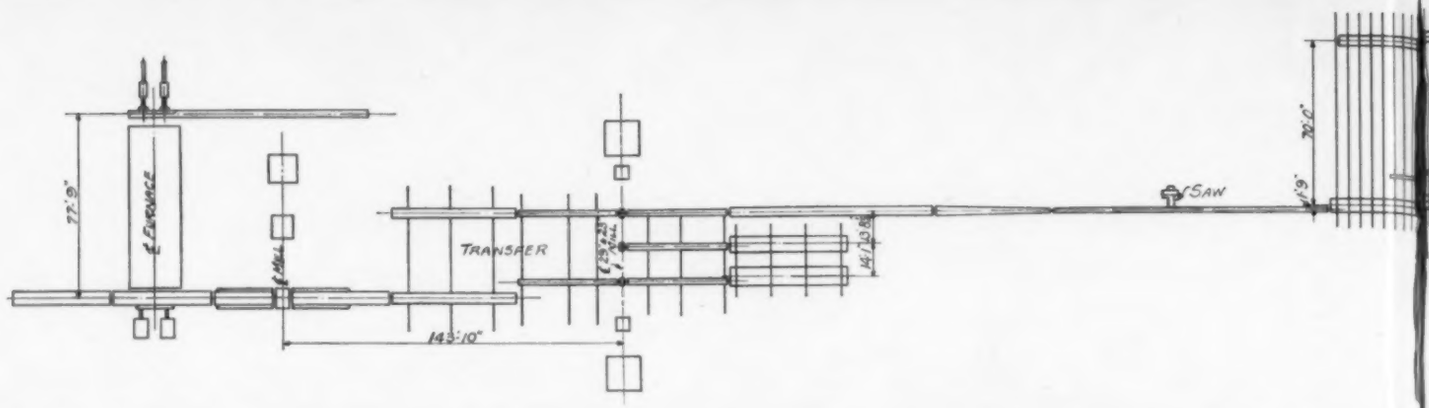
The blooming and billet mills are housed in a building 720 ft long × 70 ft wide, served by two overhead cranes, one of 30-ton and one of 15-ton capacity. The adjacent motor room is 32 ft wide. A space of 170 ft separates the blooming mill from its shear, while the 21 in. mill is about 71 ft beyond the shear. The 18 in. mill is approximately 185 ft from the 21 in. mill.

Product from the 18 in. mill usually flows to an adjacent bar yard. Slabs, blooms and billets from the blooming mill or 21 in. mill are carried over the two cooling beds previously mentioned into a slab yard, 85 ft wide × 1040 ft long, adjacent to the blooming mill building. Here these products may be inspected, and surface defects removed as required. All surface preparation is done by torch scarfing.

Slabs to be rerolled on the strip mills are transferred from the slab yard to the stockyards of the respective mills in railroad cars. Blooms to be rerolled on the adjacent structural mill are moved by a transfer car

This 40 in. blooming mill, driven by a 25,000-hp steam engine, has rolled a monthly tonnage of 182,380 net tons, charged weight.





General arrangement of the structural mill.

with roller table top. This car can receive blooms directly from the 40 in. mill cooling bed and convey them directly to the furnace charging table in the structural mill. Thus, hot steel can be charged to the structural mill furnace.

STRUCTURAL MILL

Heating facilities for the structural mill consist of one continuous recuperative furnace, 18 ft 6 in. wide × 60 ft long, and having a rated capacity of 60 tons per hour. This furnace is heated with fuel oil or coke oven gas, with combination burners arranged in four firing zones. A full complement of automatic furnace controls is provided.

Blooms are moved through the furnace over water-cooled skids and refractory soaking hearth by the action of a double pusher.

From the furnace, heated blooms pass over roller tables to a 35 in. breakdown mill, a two-high reversing unit. The rolls in this mill are 35 in. in diameter, and have a body length of 82 in. A maximum roll lift of 40½ in. is available, and mill screws, which are 12 in. in diameter with 2 in. pitch, are driven by two 100-hp mill type motors. The mill is driven by a 4000-hp, 0–50–100 rpm, 750-volt d-c motor, which receives power from a three-unit motor-generator set consisting of two 1750-kw generators and a 4900-hp, 6600-volt motor.

Mill pinions have a pitch diameter of 35 in., a circular pitch of 4.78 in. and a 48 in. face.

Motor operated side guards and manipulators handle the blooms as it is reduced in the breakdown mill.

Approximately 140 ft beyond the breakdown unit are three stands of rolls, side by side: a three-high 28 × 70 in. roughing stand, a three-high 28 × 70 in. intermediate stand, and a two-high 28 × 48 in. finishing stand. The first two stands are driven by a single 3000-hp, 70–140-rpm, 650-volt d-c motor, while the finishing stand is driven by a 2250-hp, 65–90-rpm, 600-volt d-c motor. Power for both of these drives comes from a motor-generator set composed of two 1100-kw, 650-volt generators, two 900-kw, 600-volt generators, and a 4600-hp, 6600-volt motor.

When the product to be rolled is too small for the 28-in. mill, 23-in. stands and pinions may be substituted on the same shoe plates. In either case, couplings can be put between the stands and the drives so that all three stands operate as a unit under the power of either drive. Also, a universal stand can be put in place of the conventional finishing stand when the nature of the product requires it.

The rolls in all of these stands run in composition bearings, with babbitted bearings on pinions. Rolls are adjusted by manually operated screws.

Hydraulic sprays, operating under 600 psi pressure, are installed on the finishing train of this mill.

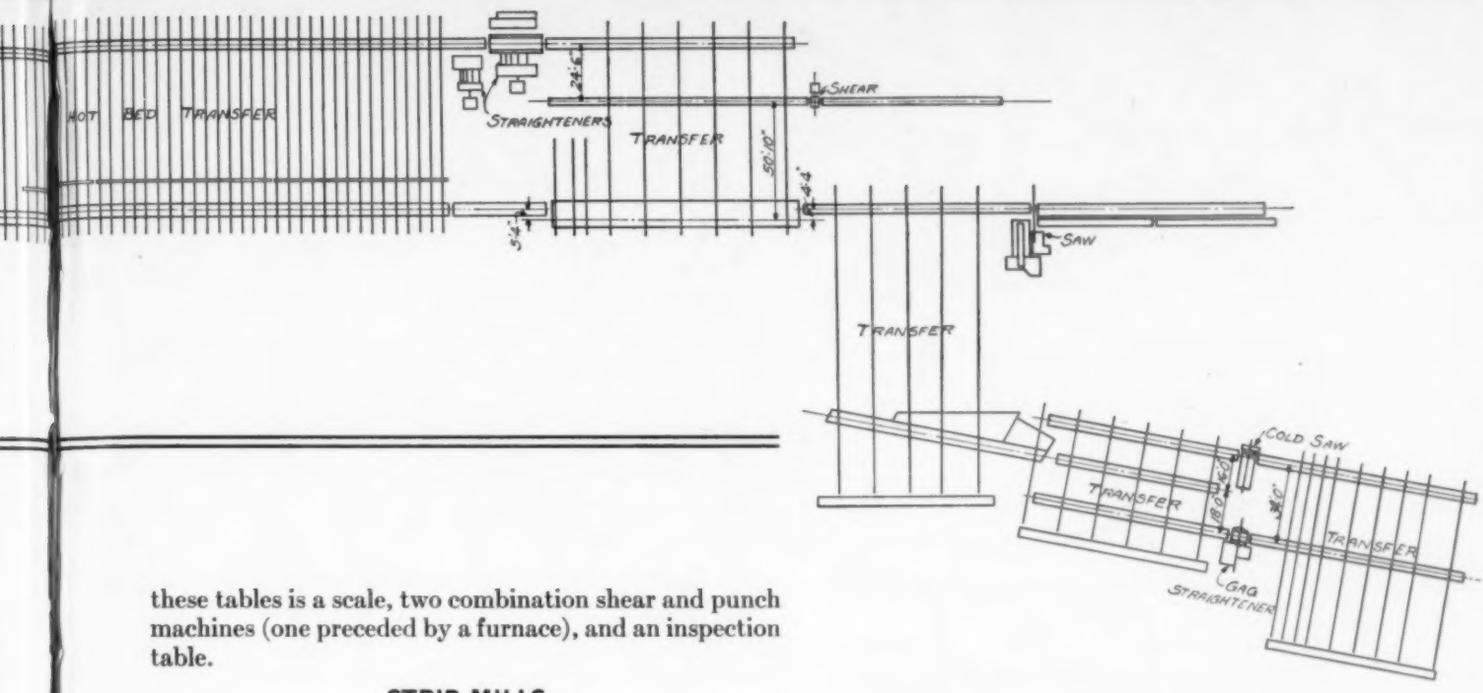
On each side of this mill are two traveling tilting tables which manipulate the steel as it passes through the mill.

Blooms entering the structural mill are 202 in. long, and range from 6 × 4 in. — 22 × 12 in. in section. Products rolled are a full range of structural shapes, including angles (2½–8 in.), channels (3–18 in.), I-beams (3–18 in.), and H-beams (6 × 6 in. to 16 × 7 in.), as well as piling, tie plate and special sections. Rolling rates range 30–200 tons per hr, depending on the product. The mill consumes 23.4 kwhr per ton of steel rolled.

Product leaving the mill is carried over the runout table to a hot saw and gage, where it is cut into desired lengths. These lengths then proceed to a three-section stationary rail type cooling table, 70 ft long and totaling 225 ft in width. At the other side of this transfer, another table conveys the sections to either of two straightening machines. One of these is a 32-in. eight-roll machine, and the other a 45 in. four-roll machine. These machines may be moved into and out of the table line by hydraulic mechanism, so that either unit may be used as desired.

Following the straighteners, the two table lines are again connected by a transfer approximately 75 ft wide. Sections may proceed over this transfer and out the original mill line, past a cold saw and on to a piler. Or they may be taken off on a third table line between the other two, where they are moved past a combination shear and punch, and on to a cradle.

Still another transfer connects the mill table line to a layout of parallel tables and transfers containing a cold saw and a gag press straightener. At the end of



these tables is a scale, two combination shear and punch machines (one preceded by a furnace), and an inspection table.

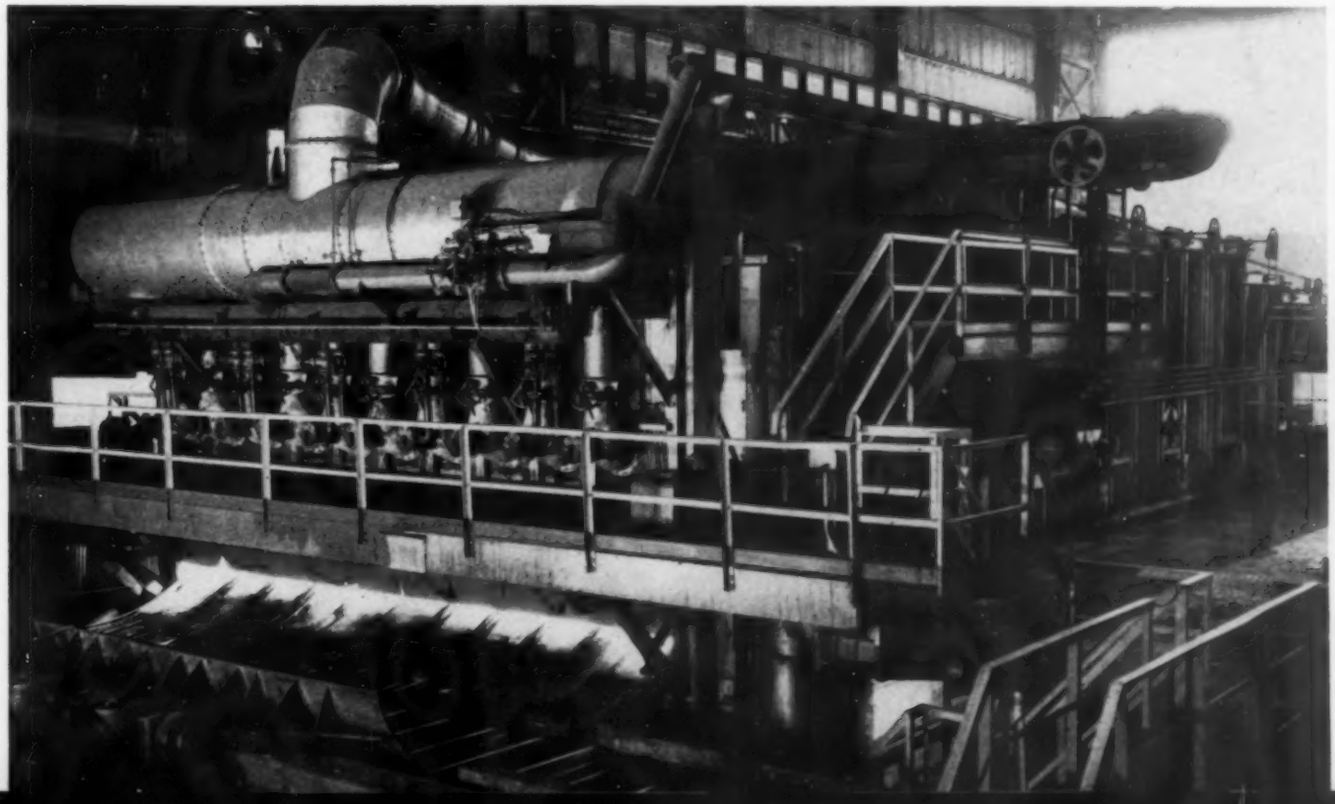
STRIP MILLS

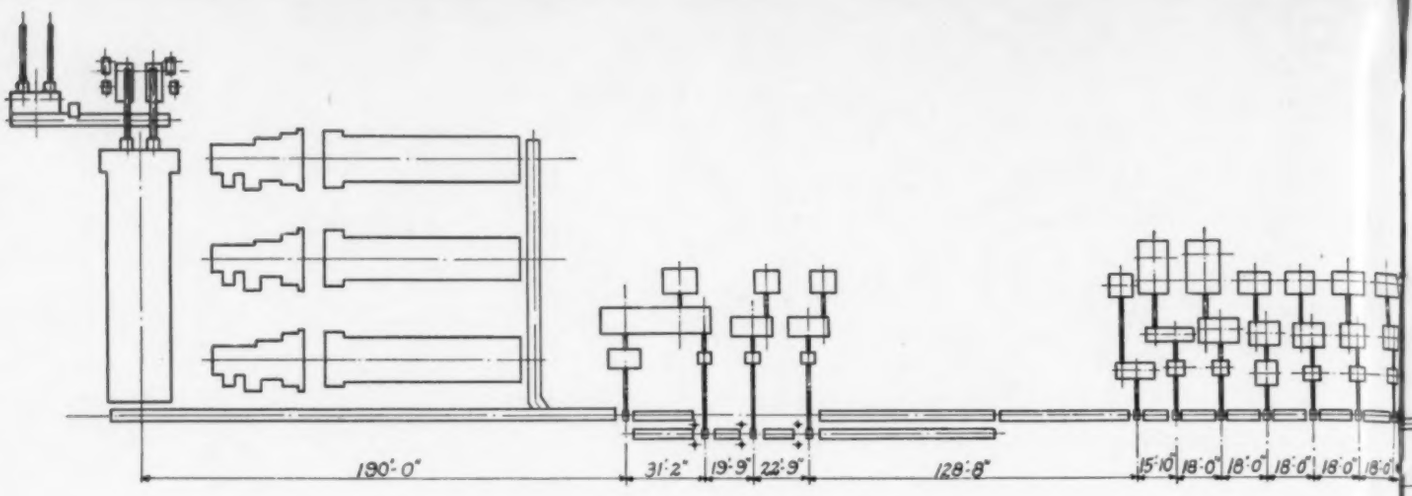
Weirton Steel Company was one of the pioneers in the strip field. In 1915 and 1916, two narrow strip mills were installed, followed in 1927 by a 48 in. mill. The wide mill now, designated a 54 in. unit, was rebuilt during 1947 to obtain greater speed and production.

Slabs to be rolled on the 54 in. mill are brought from the blooming mill in railroad cars, and are unloaded in the strip mill stockyard. Heating facilities for the strip mill consist of four continuous furnaces, equipped to burn fuel oil, coke oven gas or natural gas. Three of these furnaces are 14 ft 6 in. wide × 71 ft long, and are rated at 35 tons per hr each. These three furnaces discharge on to a roller table which connects on to the mill table line at a 90-degree angle. The fourth furnace is located along the back ends of the other furnaces. It is 28 ft wide × 98 ft long, and is rated at 120 tons per hour.

Three of these furnaces are of two-zone, top-and-bottom-fired design, using luminous flame burners. Sprung arches form the roofs, and each furnace is equipped with a tile recuperator which heats combustion air to a temperature of 500–600F. The large furnace is of three-zone design, with a suspended arch roof and a

This triple-fired, slab heating furnace, 28 ft x 98 ft, is rated at 120 tons per hour. In conjunction with three smaller furnaces, this unit serves the 54 in. strip mill.





tubular silicon-carbide recuperator. Each heating zone of the large furnace has automatic control of temperature and fuel-air ratio, and each furnace is provided with automatic pressure control. Fuel consumption averages 1,120,000 Btu per ton of slabs. A gas mixing station nearby is designed to feed a mixture of natural gas and air to these furnaces when coke oven gas is not available.

Slabs at rolling temperatures of 2250–2300F are discharged from the furnaces and pass over the delivery table to the hot mill, the first unit of which is a two-high 32 in. × 54 in. stand. The remainder of the roughing train consists of three four-high 18 in. and 40¼ in. × 54 in. stands. The first two stands of this train are driven by one 1500-hp, 6600-volt, 200-rpm induction motor through a combination gear reduction set. The third and fourth stands are each driven by a 1500-hp, 6600-volt, 450-rpm induction motor. The alinement of the roughing stands is somewhat unusual, in that the last three stands of the train are not in line with the first stand, (which is in line with the finishing train), but are placed in a parallel line about 18 ft to the side. Thus, the slab must be transferred back and forth between the two table lines by turnover mechanisms. This arrangement, which remains from the original mill layout, was originally designed to aid scale removal.

Linear spacing of the roughing train is 31 ft 2 in., 19 ft 9 in., and 22 ft 9 in., respectively, between successive stands. Integral vertical edging rolls are provided on the three four-high roughers, each pair driven by a separate 500 hp motor.

A space of 128 ft 8 in. separates the roughing and finishing trains.

The finishing train is composed of a two-high, 22 in. × 54 in. scalebreaker, driven by a 500-hp, 600-volt, 160–525-rpm d-c motor, followed at a distance of 15 ft 10 in. by the first of six finishing stands. The first two finishing stands are four-high 19 in. and 46¾ in. × 54 in. units, driven by 600-volt, 200–400-rpm d-c motors rated respectively at 4000 and 5000 hp. The last four stands are four-high 23½ in. and 49 in. × 66 in., each driven by a 3500-hp, 600-volt, 175–350-rpm motor. The finishing stands are spaced on 18 ft centers.

Power for the finishing train motors is supplied by three motor-generator sets operating in parallel with two multi-tank mercury arc rectifiers. This unusual arrangement has been in service for more than a year, and has been perfectly satisfactory. Each rectifier is rated at 3500 kw, 600 volt, while each motor-generator set consists of two 1500-kw, 600-volt generators and a 4200-hp, 6600-volt synchronous drive motor.

These units, as well as the mill drive motors, switch gear, and motor-generator sets for runout table, coilers, excitation and auxiliary equipment, are located in a motor room 43 ft wide × 525 ft long located in the hot mill building alongside the mill. Rotating equipment is cooled by air blown up through the machines from the basement. Fresh air is drawn into the basement through electrostatic precipitators.

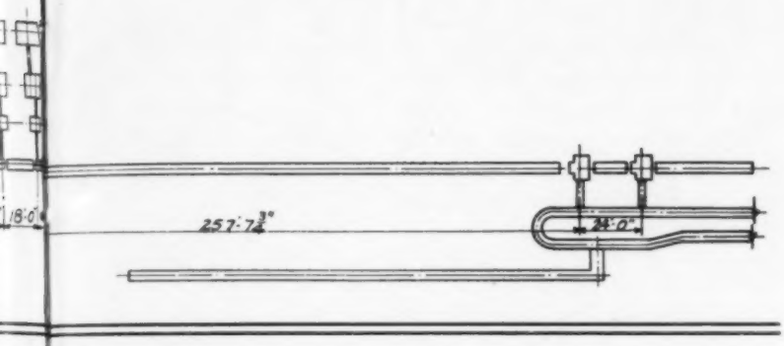
Five loopers, two operated by air and three by torque motors under load relay control, are installed between the six finishing stands, and serve to control slack occurring in the strip between stands.

Bronze bearings are used on the roll necks of both scalebreakers, and for the work rolls of stands No. 2, 3, 4, 5 and 6. The back-up rolls of these stands operate in roller bearings. In stands No. 7, 8, 9 and 10, work rolls run in roller bearings, while oil-film bearings are applied on back-up rolls. Rolls are hydraulically balanced in stands No. 7, 8, 9 and 10, and spring balanced on the other stands.

Screwdowns in each roughing stand of the hot mill are driven by a single 12–15-hp, d-c motor, while each finishing stand is served by two 25-hp d-c motors. Magnetic clutches are installed in the operating mechanisms where two motors are used.

To insure a high quality of strip surface, hydraulic descaling sprays are placed, top and bottom, at the entry to No. 2 rougher and at the exit of the finishing scalebreaker. Sprays are controlled by 220-volt thrusters, and water is supplied by three 1500-gpm, 1100-psi centrifugal pumps.

General arrangement of the 54 in. hot strip mill.



Gear ratios and mill speeds in the hot mill are as follows:

Stand	Gear ratio	Roll rpm	Roll speed, fpm
No. 1 rougher	15.7	12.7	103
No. 2 rougher	6.0	30.0	142
No. 3 rougher	7.6	50.8	275
No. 4 rougher	5.2	85.5	402
Finishing scalebreaker	11.15	144–47	83–271
No. 5 finisher	4.97	40–80	174–348
No. 6 finisher	3.26	61–123	266–532
No. 7 finisher	2.64	66–132	398–796
No. 8 finisher	1.98	88–177	533–1066
No. 9 finisher	1.58	111–222	668–1336
No. 10 finisher	1.32	132–264	795–1590

Slabs entering the hot mill range 22–48 in. in width, 3½–5½ in. in thickness, and 72–152 in. in length, and may weigh 2250–7300 lb. A usual size is 30 in. × 5 in. × 142 in., weighing about 6000 lb.

The mill produces strip 22–40 in. wide in gages as light as No. 18, widths up to 43 in. for No. 16 gage, and up to 48 in. wide in No. 14 gage and heavier. Average gage of product is 0.080 in. Rolling rates average about 190 tons per hr, and approximately 65 kwhr are consumed by hot mill drives and auxiliaries per ton of strip.

Typical reductions through the hot mill stands are approximately as follows:

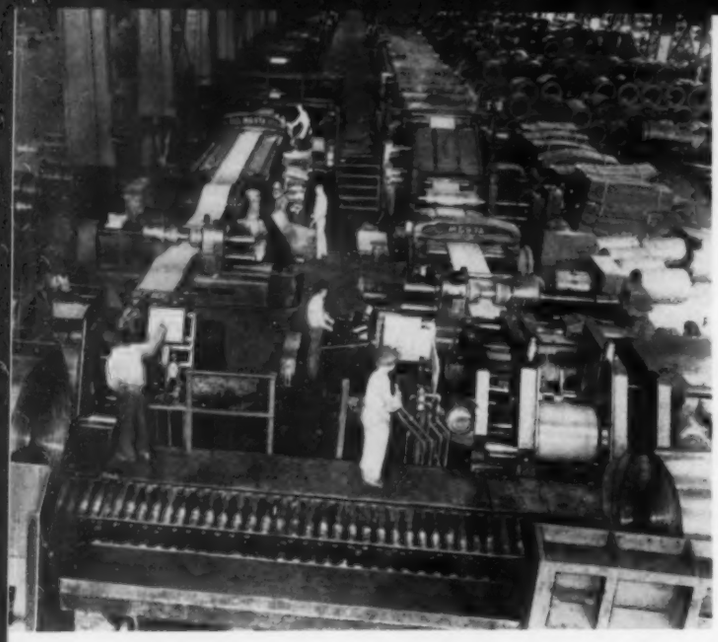
	Per cent
No. 1	30
No. 2	35
No. 3	35
No. 4	31
No. 5	43
No. 6	43
No. 7	43
No. 8	30
No. 9	30
No. 10	25

From the last finishing stand the runout table extends about 260 ft to two down-coilers. From the coilers, coils are discharged so as to stand on end on an oval-shaped car conveyor composed of 106 cars, each 6 ft long. This conveyor is arranged so that it travels in a long loop under the mill floor, giving the coils time to cool before they reach an unloading station. Here the coils are removed and placed in cradles on an inclined conveyor that carries them up to floor level, where they are then taken to the pickling department.

Three continuous pickling lines about 650 ft long prepare the strip for subsequent cold reduction. One of these is an old unit, while the other two are modern. Another new unit is being put in to replace the old line. Each line contains four acid tanks and one rinse tank. In the old line, the acid tanks are 60 ft long, 5 ft wide and 4 ft deep, and are built of brick lined lead. This line operates in a 60-180 fpm speed range. In the two

With delivery speeds up to 1590 fpm, the 54 in. mill produces strip up to 48 in. wide. Rolling rates average about 190 tons per hour.

A car conveyor, arranged in a large oval loop under the mill floor, provides time for the hot-rolled coils to cool before they are moved to the pickling department.



Each pickling line contains four acid tanks 80 ft long, and operates in a speed range of 110-450 fpm.

This unusual conveyor, which carries pickled coils to the new cold mill, travels on an elevated track, freeing the floor space that would otherwise be required.

new lines, acid tanks are built of steel, lined with rubber and brick, and are 80 ft long, 6 ft wide, and 4 ft deep. These units operate at 110–450 fpm.

Pickling solutions are kept at 18–25 per cent sulphuric acid strength, and are heated by steam jets under automatic temperature control to about 220F.

From the exit ends of the pickling lines, coils are moved by conveyors to the cold reduction mills. One conveyor line leads over to the cold mill bay where three older mills are installed. An unusual new overhead conveyor leads from the exit of the picklers back to the location of a new high speed mill. This installation is an overhead track supported on structural steel and carrying an endless flight conveyor with cradles upon which the pickled coils are transported.

Cold reduction facilities consist of five tandem cold mills. The first of these is a four-stand train of four-high, 16 in. and 38¼ in. × 48 in. units, each driven by a 500-hp, 600-volt, 400–800-rpm d-c motor. This mill can roll widths up to 46 in. in gages down to 0.029 in.

Another train is very similar, except that its width is only 42 in. Widths up to 36½ in. can be produced in gages down to 0.029 in. In both of these mills, stands are spaced on 25 ft centers, roller bearings are used on work rolls and back-up rolls, and maximum delivery speed is 470 fpm. Each mill receives power from a 1500 kw motor-generator set.

A third tandem mill, located near the preceding units, consists of four 4-high 19 in. and 48½ in. × 36 in. stands. The drive motors, all 600 volt d-c, are, respectively, 400-hp, 600–1200-rpm; 1000-hp, 400–800-rpm; 1000-hp, 400–800-rpm; and 1500-hp, 300–700-rpm. This mill has a maximum delivery speed of 1520 fpm. Roller bearings are used on all work rolls of this mill and on the back-up rolls of the first two stands. Oil film bearings are applied to the back-up rolls of the last two stands. Power for this mill comes from a 3500-kw motor-generator set. Gages down to 0.0075 in. can be produced in widths up to 34 in.

Located in another building adjacent to the pickling building is a fourth tandem mill. This is also a four-stand, four-high train, 19 in. and 45 in. × 36 in. Stands in this mill, as well as in the preceding one, are spaced 12 ft 7 in., 11 ft 9 in., and 11 ft 9 in. apart, successively. The maximum delivery speed of this mill is 2445 fpm, and the drive motors are rated, respectively, at 700-hp, 350-875-rpm; 1750-hp, 300–600-rpm; 1750-hp, 175–350-rpm; and 2500-hp, 250–500-rpm. All of these motors are 750 volts d-c. All work rolls in this mill operate in roller bearings, as do the back-up rolls of the first stand. The last three stands are equipped with oil film bearings on the back-up rolls. A motor-generator set, consisting of two 3000-kw generators and an 8400-hp drive motor. This mill can also produce 0.0075 in. gage in 34 in. width.

A recent addition to the cold reduction facilities of this plant is a five-stand, four-high tandem mill having a maximum delivery speed of 4950-fpm. Work rolls are of 21 in. diameter and 42 in. body length and run in four-row tapered roller bearings. Back-up rolls, operating in oil film bearings, are 53 in. in diameter × 41 in. body length. Rolls are balanced through a 2000 psi oil-hydraulic system. The mill stands are spaced on 13 ft centers.

The first stand of this new mill is driven by a 1750-hp, 70–210-rpm motor. The second stand has a 3500-hp, 125–312.5-rpm motor, and the third a double armature, 3500-hp, 225–450-rpm motor. All of these drives are direct, without reduction gears. Stands No. 4 and 5, however, are driven by twin motor drives through speed-up gear sets. Two 1750-hp, 348-696-rpm motors serve No. 4 stand, and two 2250-hp, 500–900-rpm motor are used on No. 5 stand.

The use of twin drives on cold strip mills, with each work roll individually driven by a motor, is a new application of a principle previously used on some blooming and plate mills.

The main drives, rated at 750 volts, operate on adjustable voltage, and are designed and controlled so that constant speed relations between the various stands are maintained at all speeds from threading to maximum. The mill can be accelerated from threading

up to 4000 fpm in nine seconds, and can be stopped from a running speed of 5000 fpm in approximately four seconds.

Following the last stand is a 16½ in. diameter expanding reel, driven by two 400-hp, 750-volt, 300–1100-rpm d-c motors.

Power for the drive motors is supplied from two motor-generator sets, each composed of two 3500-kw, 750-volt d-c generators driven by a 9900-hp, 6600-volt motor. Exciter and booster units are grouped into an eleven-unit set driven by a 1500-hp motor.

One 1000 psi hydraulic accumulator system serves to actuate the uncoiler, reel stripper, roll changing rig, and various other motions. Lubrication is provided by four circulating oil systems, two automatic grease systems and two manual grease systems. Palm oil, applied to top and bottom of the strip to cool and lubricate it as it is reduced, is supplied from a system containing the usual pumps, coolers, etc.

This mill produces strip up to 40 in. wide, and can go down to 0.0075 in. gage in widths up to 34 in.

An inspection of the characteristics of the foregoing cold reduction mills offers a typical study of cold mill development. The early mills, with a delivery speed of 470 fpm, used drive motors of 500 hp. Next is a speed of 1500 rpm, and motors of 1000–1500 hp. Then comes 2500 fpm, and motors up to 2500 hp, and recently, 5000 fpm with drives up to 4500 hp per stand. Even the screwdown drives reflect the trend, ranging from two 6-hp motors on the old mills, through two 12-hp units and on to two 50-hp motors in the newest mill.

Strip and sheet finishing equipment is variously located in four separate areas. In the strip mill unit itself, which is devoted principally to the finishing of sheets, there are 18 radiant tube annealing covers ranging 15½–22 ft in length, 6½–15½ ft in width, and 58–90 in. in height. Three bases are provided for each cover. These furnaces are fired by coke oven gas. Annealing temperatures are usually between 1200 and 1260F, and the entire annealing cycle covers about 130 hours. Product may be annealed in coil or sheet form.

There is also one continuous roller-hearth normalizing furnace here, 72 in. wide and 150 ft long. This furnace operates at speeds of 10–40 fpm, and has a capacity of 200 tons per day. It is fired with coke oven gas or natural gas.

Temper mills in this department include two 2-high 20 in. × 48 in. single stand units, each driven by a 150-hp motor; one 4-high, 16 in. and 38½ in. × 48 in. mill driven by 250-hp motors; one 4-high, 16 in. and 38½ in. × 42 in. mill driven by a 250-hp motor; and one 4-high, 20½ in. and 49 in. × 54 in. mill, driven by a 500-hp motor. There are also two processing lines for sheets, each composed of a belt conveyor, a stand of rolls, a dryer, leveler, and piler.

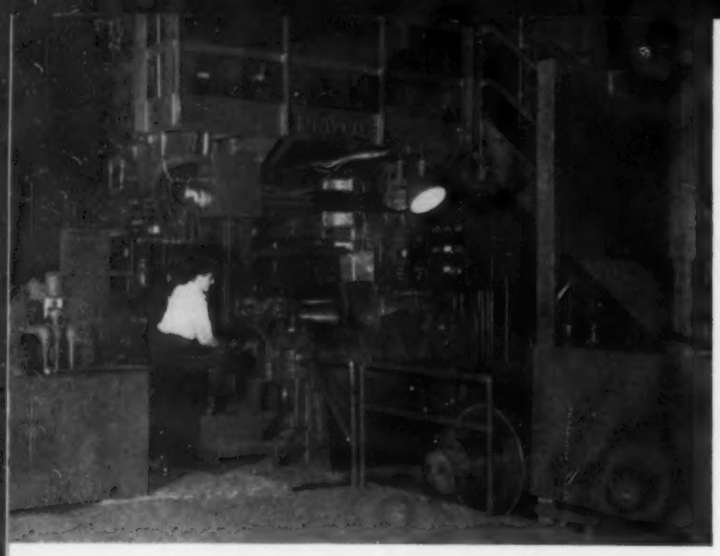
Additional equipment here includes two cutting-slitting lines, one batch pickler, four resquaring shears, two roller levelers, one stretcher leveler, three slitters, and one combination cutter and resquaring shear.

WEIRTON SHEET MILL

Another finishing center, devoted principally to galvanizing and terne coating, is located in the old sheet mill buildings, from which the old equipment has been removed. Here are located eight radiant tube annealing covers for coils, and eleven more covers for use on sheet lengths, all burning coke oven gas.

One 2-high 28 in. × 54 in. temper mill is installed here, and there are also five stands of two high, 28 in. × 66 in. cold mills in a line driven by one 1200-hp motor.

This recently installed 42 in. tandem cold mill is driven by motors totaling 16,750 hp, and has a top delivery speed of 4950 fpm. It can produce strip down to 0.0075 in. gage in widths up to 34 in.



A number of temper mills, of various sizes and types, are located in the four finishing centers devoted to the final processing of strip.

Cut lengths may be pickled in six 2½-ton batch type picklers, and coating facilities include one terne pot, one lead spelter pot and five galvanizing pots, each capable of taking sheets up to 40 in. × 144 in. There is also one recently installed continuous galvanizing line capable of taking sheets up to 48 in. × 144 in. This unit can coat 6–7 tons of sheets per hour.

One electrolytic cleaning line has been installed in this department to augment tin plate finishing facilities.

WEIRTON TIN MILL

Still another center of finishing activity is the tinning department, which is located at the north end of the plant. Coils from the cold reduction mills at the strip plant are brought here in railroad cars to be finished into tin plate.

Two electrolytic cleaning lines, 27 radiant tube annealing covers, and two skin pass mills are installed here. Each of these mills consists of one 4-high, 8 in. and 38 in. × 42 in. stand and one 2-high, 27 in. × 42 in. stand, each stand driven by a 500-hp motor. It is planned to install a third mill of this type.

Steel to be coated by the conventional hot dip process is first cut to length by two flying shear lines, white pickled in two batch type picklers, and then it proceeds to 33 hot dip tin pots.

For electro-tinning, the stock is kept in coil form until the tinning operation is complete. Three continuous electroplating lines are installed. These units are approximately 550 ft overall length, and include uncoilers, pinch rolls, shear, seam welder, looping pit, tension rolls, electro cleaner, pickling tank, scrubber, plating tanks, rinse tank, reflow unit, quench tank, tension rolls, chemical dip tank, oil tank, shear, and recoiling reels. In the plating zone, which consists of 24 sections with anodes only on the bottom of the tank, the bottom side of the strip is plated in the first 12 sections, then the strip doubles back over itself and the other side, now on the bottom, is plated in the next 12 sections. The strip then again doubles back to pass through the rinse tank.

The solution used in the plating tanks is the acid type, containing tin chlorides and fluorides. Tin content of the bath is varied in accordance with current density and strip speed. A bath temperature of about 150F is maintained. Strip speed usually ranges 750–1250 fpm, at which speeds tin coatings of 0.75–0.5 lb per base box are obtained. Current densities vary between 250 and 350 amp per sq ft, the plating current coming from motor-generator sets totaling 120,000 amp per line. Reflow on all three lines is by induction heating.

At present, only two of these plating lines are being used for tinning, while one is being used as an electrogalvanizing line.

Strip coated in the electroplating lines is recoiled at the end of the process, in order that the speed of the plating lines need not be limited by the slower speed of shearing equipment. The coils are then subsequently cut up on four flying shear lines.

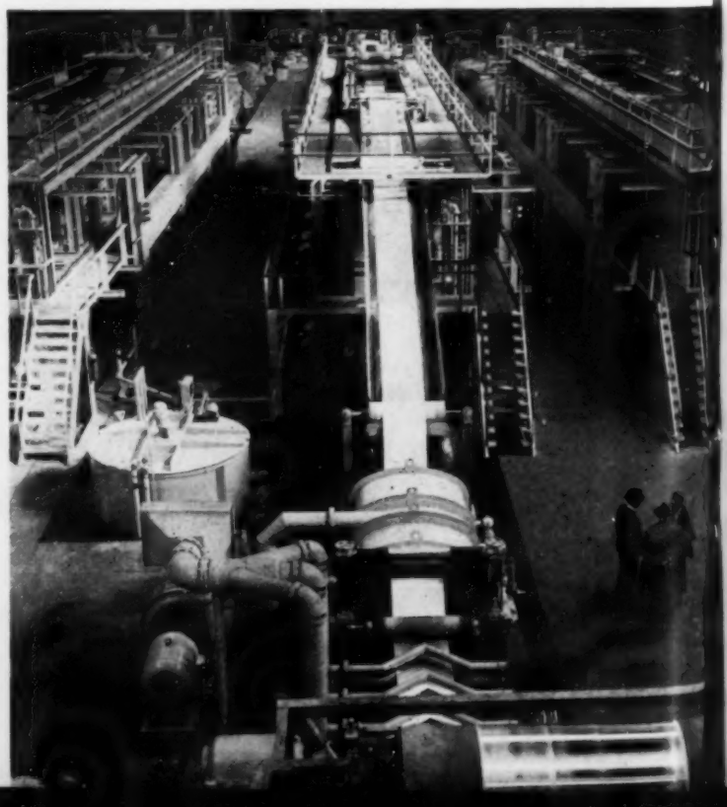
STEUBENVILLE TIN MILL

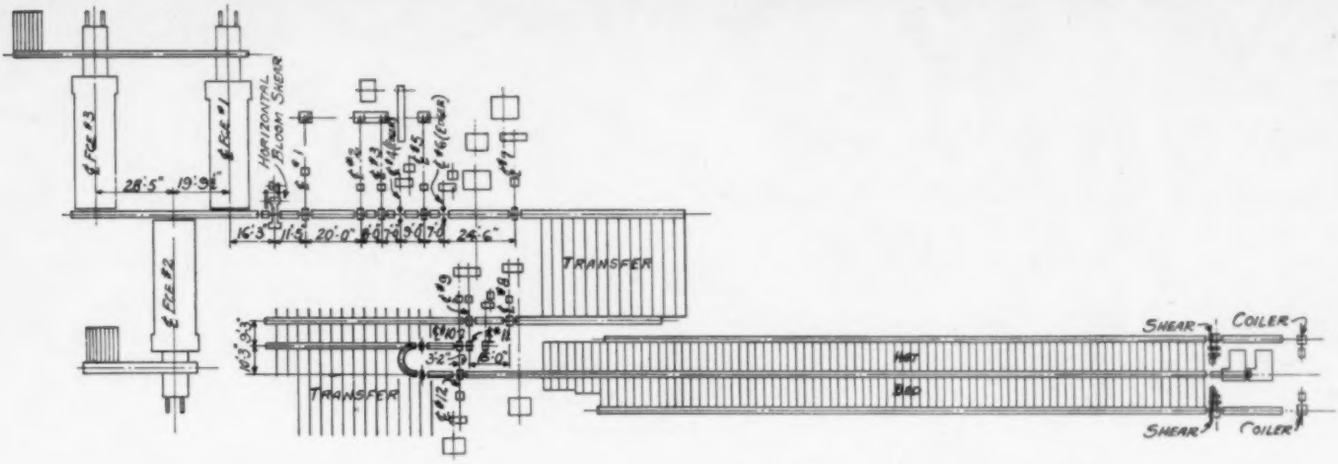
A fourth finishing department, which is also devoted to tin plate, is located in Steubenville, Ohio, some 5 miles from Weirton. This is the old tin plate plant originally purchased in 1911, but the old mills have given way to newer equipment used in the processing of cold reduced plate. This plant now includes two electrolytic cleaning lines, 16 radiant tube annealing covers for coil stock, two 2-stand skin pass mills duplicating those in the Weirton tin mill, four flying shear cut-up lines, two batch type white picklers, 26 hot dip tin pots, and complete facilities for assorting.

Coils from the cold reduction mills at the strip plant are brought to Steubenville in railroad cars. Finished tin plate is shipped direct from this plant.

In the foregoing, it will be noticed that several steps in the strip finishing process require movement by rail.

Three continuous electroplating lines are installed in the tin mill. At present, two of these are used for tinning, while one is electrogalvanizing.





General arrangement of 16 in. strip mill.

These movements are made in freight cars having reinforced floors to withstand the concentrated loads. Electric trucks are used to load box cars, while the heavier coils (over 15,000 lb) are handled by overhead crane and loaded on flatcars or gondolas. Electric trucks are also used extensively in moving coils and sheared lengths between the various steps in the finishing process.

NARROW STRIP MILLS

Although originally installed as strip mills, the 16-in. and 10-in. mills have since been adapted to the production of various other products.

The 16-in. mill is served by three continuous furnaces, with hearths 40 ft long × 12 ft wide. Top-fired with coke ovens gas or liquid fuel through four burners, each furnace has a capacity of 12.5 tons per hour. Fuel consumption averages 3,000,000 Btu per gross ton of slabs heated.

Heated slabs are expelled, by the action of furnace pushers, from the furnace on to a roller table which leads to the mill stands.

The mill stands are as shown in Table II. The first seven stands are in a single direct line. After the seventh stand, the steel is moved over a transfer approximately 60 ft wide × 36 ft long to a parallel table line which contains the eighth and ninth roll stands, through which the direction of travel is in the direction opposite that in the roughing train. Again the steel is moved over a transfer to another table line, and the direction of rolling again reversed as the steel passes through stand No. 10. The strip passes through the tenth stand on one pass level, and is returned by a duo repeater back through a higher pass level in stand No. 11. Upon final exit from No. 11 stand, the strip passes through another repeater and on through the final finishing stand.

Seven motors drive the 12 stands of the 16 in. mill. A 1500-hp, 505-rpm, 6600-volt wound rotor induction motor drives stands No. 1, 2, 3 and 5, through shafts and gearing. No. 4 edger is driven by a 150-hp motor, and No. 6 edger is driven by a 100-hp motor, both 250-volt, d-c units.

No. 7 stand is driven by a 1500-hp, 514-rpm, 6600-volt wound rotor induction motor, while No. 8 stand is driven by a Kramer system unit composed of a 1500-hp, 257–508-rpm, 6600-volt a-c motor, a 750-hp, d-c motor and a 930-kw rotary converter.

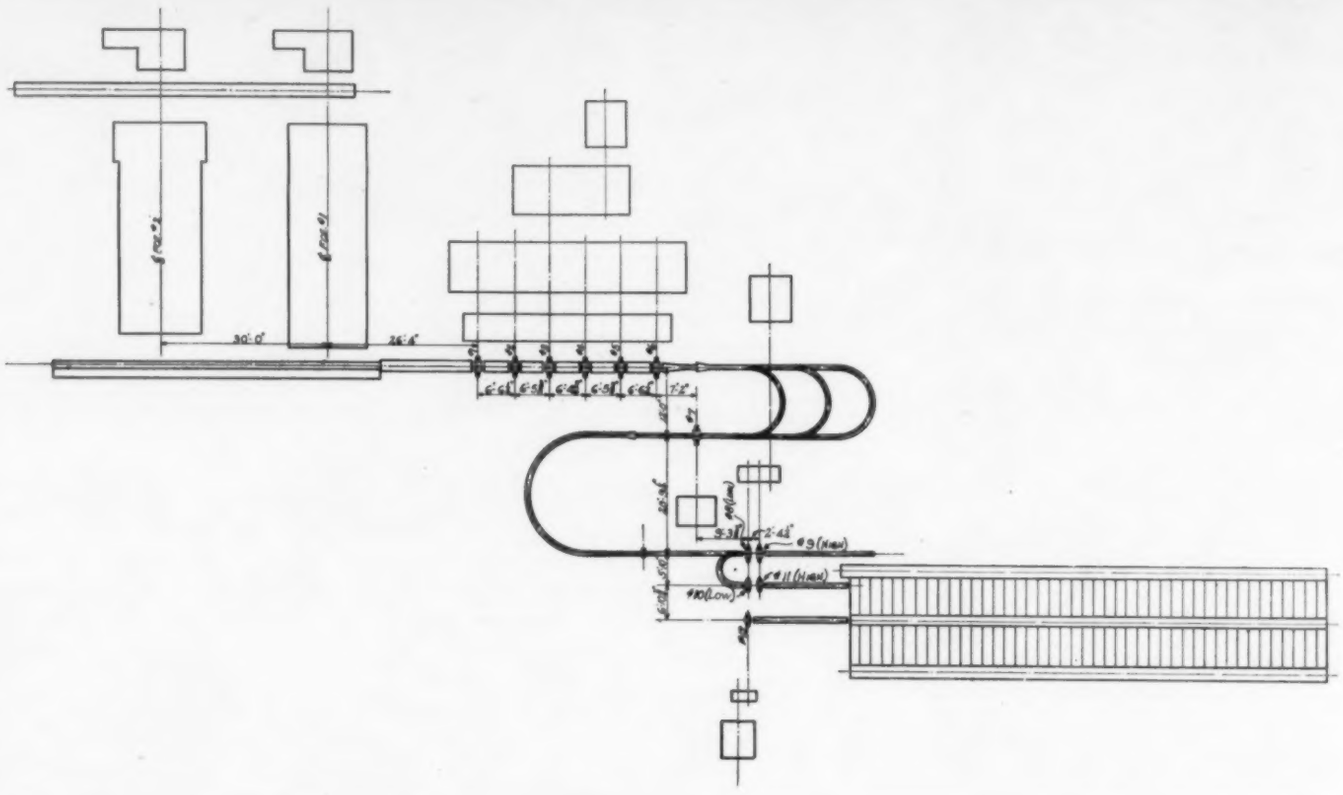
Stands No. 9, 10 and 11 are driven by a Kramer unit consisting of a 2500-hp, 177–354-rpm, 6600-volt, a-c motor, a 1050-hp, d-c motor, and a 1400-kw rotary converter. Finally, No. 12 stand is driven by a third Kramer system that includes a 1200-hp, 303-505-rpm, 6600-volt a-c motor, a 450-hp, d-c motor, and a 360-kw rotary converter.

Brass bearings are used on the roll necks of the first

TABLE II

Data on 16 in. Mill

Stand	Designation	Roll, in.		Distance from preceding stand, ft-in.	Roll speed, rpm	Strip speed, fpm
		Body length	Diameter			
1	Horizontal edger	..	....	....	....	....
2	2-high	24	21½	20–0	18.4	103
3	2-high	24	20½	8–0	31.8	170
4	Vertical edger	..	..	7–0	....	....
5	2-high	24	19½	9–0	58	295
6	Vertical edger	..	....	7–0	....	....
7	2-high	24	18½	25–6	92	445
8	2-high finisher	24	16	....	70–137	295–575
9	2-high finisher	24	16	15–0	100–200	420–840
10	2-high finisher	24	16	....	88–176	370–740
11	2-high finisher	24	16	3.2	100–200	420–840
12	2-high finisher	24	16	....	138–230	580–980



General arrangement of 10 in. strip mill.

seven stands of this mill, and fabric bearings on the last five stands. All pinions run in brass bearings, and babbitted bearings are used on the bearings of the gearing.

Descaling sprays are located at the entrance to stands No. 2, 4, 7, 8 and 10. Water is supplied to these sprays from an 800-gpm, 800-psi pump.

Leaving the 16 in. mill, the strip passes over a runout table to a double cooling bed 15 ft wide on each side of the runout, and 250 ft long. At the end of this hot bed are vertical shears and motor-driven coilers.

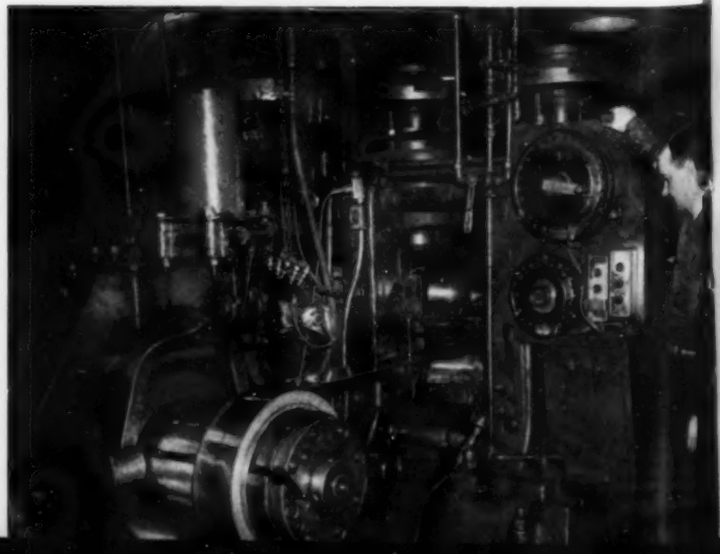
Slabs entering the 16 in. mill range 4–8 in. in width, ¾ in. in thickness, 48–120 in. in length, and 250–1800 lb in weight, and the product is strip 2½–21½ in. wide and 0.035–0.500 in. thick. Some structural shapes may also be produced. This mill rolls at an average rate of about 30 tons per hr. The main drives consume approximately 45.5 kwhr per ton of strip, while auxiliaries require an additional 22.5 kwhr per ton.

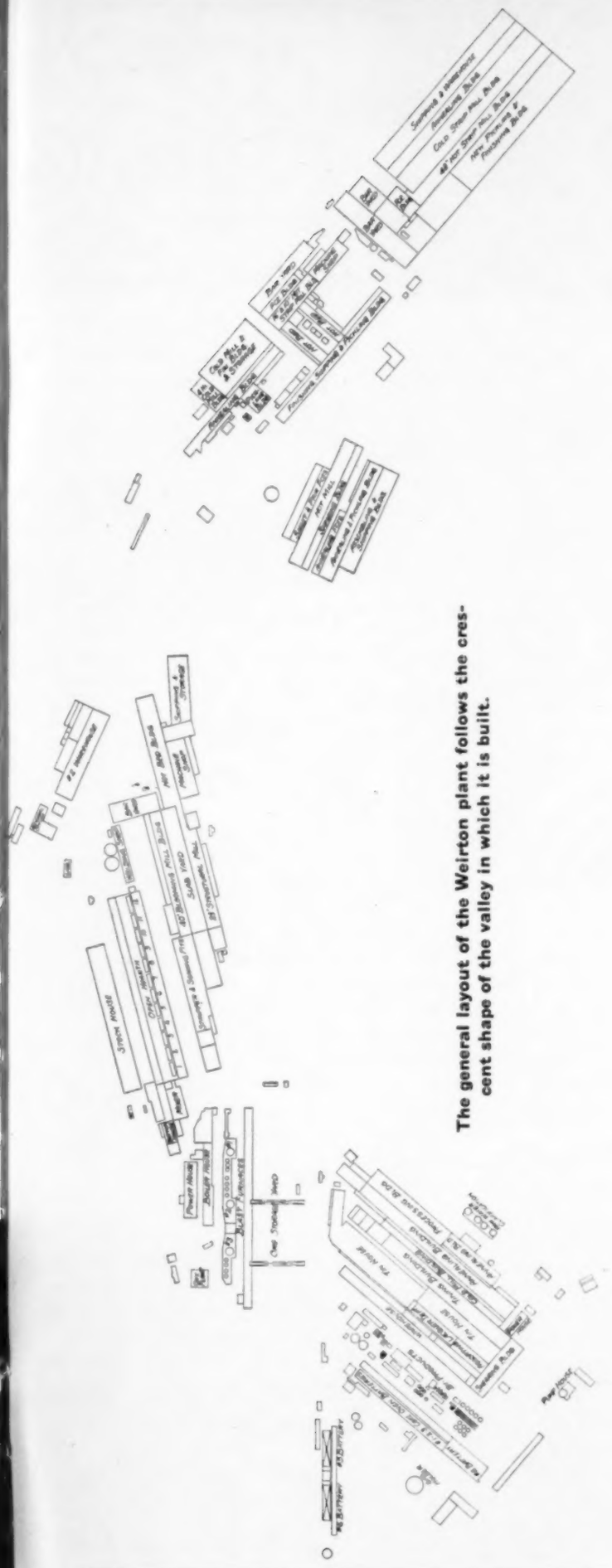
Located adjacent to the 16 in. mill is a 10 in. mill. Two furnaces, duplicating those on the 16 in. mill, heat billets which are then conveyed to a continuous 6-stand roughing train. These stands, spaced 6 ft 6 in. apart, are in a single line. From the sixth stand, the steel is looped around in a repeater, and passes back through No. 7 stand. Another repeater again reverses the directions of rolling and the steel passes through No. 8 and 9 stands in a duo arrangement. Another reversal in a repeater and the steel goes through No. 10 and 11 stands, also a duo arrangement. The first pass of each duo is low, with the second pass above. Leaving No. 11 stand, the steel is manually looped around into No. 12 stand. Delivery speed from this stand ranges 800–1300 fpm.

Data on sizes and speeds of the various stands are given in Table III.

Four motors drive all of the stands in the 10 in. mill. The six roughing stands are driven through a large gear train by a single 1500-hp, 508-rpm, 6600-volt wound rotor induction motor. No. 7 stand is driven by a 500-hp, 175–300-rpm 250-volt, d-c motor. The two duo mills, which include stands No. 8, 9, 10 and 11, are driven by a Kramer drive composed of a 1500-hp, 257–508-rpm, 6600-volt, a-c motor, a 750-hp d-c motor,

This cold mill is one unit in the complete layout of facilities for finishing narrow strip from the 16 in. and 10 in. mills.





The general layout of the Weirton plant follows the crescent shape of the valley in which it is built.

and a 600-kw rotary converter. No. 12 stand is also driven by a Kramer unit consisting of an 800-hp, 300–600-rpm, 6600-volt, a-c motor, a 350-hp, d-c motor, and a 300 kw-converter.

Roll necks of the roughing stands run in brass bearings, with composition bearings on the finishing stands.

Descaling sprays, supplied from an 800-gpm, 800-psi pump, are placed at the exit of stands No. 3, 7 and 8.

Product flowing from the 10 in. mill may proceed either to coilers near the mill or over a runout placed between a double unit cooling bed 250 ft long. Coilers are also installed at the end of this runout. Product not intended to be coiled passes over the cooling bed. Shears at the ends of the hot bed exit conveyors may be used to cut lengths as desired.

Products of the 10 in. mill include strips up to 7¼ in. wide in thicknesses from 0.500 in. to No. 16 gage; rounds and squares, ½–1½ in.; and angles, 1–2½ in. Rolling rates average 17–20 tons per hr, and power

TABLE III — Data on 10 in. Mill

Stand	Designation	Roll body length, in.	Roll diameter, in.	Distance from preceding stand, ft-in.
1	Flat	24	16	....
2	Flat box	24	13½	6–6
3	Edger	24	13	6–6
4	Flat	24	12½	6–6
5	Flat	24	12½	6–6
6	Flat	24	12½	6–6
7	Edger	24	....	....
8	Finisher	14	11½	....
9	Finisher	14	11½	2–4½
10	Finisher	14	11½	....
11	Finisher	14	11½	2–4½
12	Finisher	14	14	....

consumption runs 51 kwhr per ton for main drives and 42.3 kwhr per ton for mill auxiliaries.

The finishing department serving the 16 in. and 10 in. mills is located at one end of the mill building. This department contains one 6-strand continuous pickler, 370 ft long overall and containing two rubber-lined steel tanks 100 ft long × 60 in. wide. Strip speed through this line ranges 60–240 fpm. The entry and exit ends of the line are in separate buildings, with the tanks placed outdoors between the two buildings.

Four tandem cold mills are located here. One of these is a four-stand, two-high, 16 in. × 24 in. unit driven by three 300-hp, 400–800-rpm, 250-volt, d-c motors and one 250-hp, 300–900-rpm, 250-volt, d-c motor. This mill has a delivery speed of 60–208 rpm. A second mill is a three-stand, two-high, 12½ in. × 16 in. unit, driven by three 100-hp, 400–800-rpm, 250-volt, d-c motors. Delivery speed from this mill is 70–267 fpm.

Still another cold mill is a four-stand, two-high, 12½ in. × 16 in. mill powered by four 100-hp, 400–800-rpm, 250-volt, d-c motors. Exit speed of this mill ranges 60–200 fpm. The fourth unit is a four-stand, two-high 12½ in. × 10 in. tandem train driven by four 150-hp, 400–800-rpm, 250-volt, d-c motors. A delivery speed range of 70-273 fpm is available.

All of these tandem mills have fabric bearings on the

These three units are part of the all-diesel locomotive fleet by which all plant shifting is done.

roll necks, and roller bearings on pinions and gears. Screwdowns are manually operated. All stands in the respective mills are spaced on 17 ft 4 in. centers, and each mill has a recoiling reel. The 24 in. mill also has a shear at its exit end.

These mills produce cold rolled strip 8–21 in. wide and 0.015–0.030 in. thick.

There are also four single-stand skin pass mills 17½–24 in. wide, and two edging mills.

Annealing facilities in this department consist of eleven portable radiant-tube covers 19½–22½ ft long and 8–9½ ft wide. Three bases are provided for each cover. Furnace charges average 48 tons, with a cycle totaling 128 hours and temperatures ranging 1150–1310F. The covers are fired with coke oven gas, and fuel consumption averages about 1,500,000 Btu per ton.

There are three continuous normalizing furnaces, one 64 in. wide × 100 ft long and two 48 in. wide × 125 ft long. These furnaces burn coke oven gas and natural gas.

In addition to the foregoing, finishing equipment also includes four stationary tub batch picklers, seven levelers, eleven slitters, three cut-up units, one oiler, resquaring shears, etc.

PLANT SERVICES

Most of the electric power used in the Weirton plant is generated in the plant. Producing units include eight turbogenerators, three of which are high-pressure units. The newest unit is a 25,000-kw, 80 per cent power factor, 13,800-volt, 3-phase, 60-cycle machine driven by a 3600-rpm, 800-psi, 800F, impulse reaction type condensing turbine.

There are two 10,000-kw, 80 per cent power factor, 6900-volt, 3-phase, 60-cycle units, driven by 3600-rpm, 800-psi, 800F non-condensing turbines. These two units exhaust at 225 psi into the low pressure steam system. Five 7500-kw, 6900-volt, 3-phase 60-cycle generators, each driven by an 1800-rpm, 225-psi, 550F condensing turbine, complete the generating equipment. All condensing equipment is of the barometric type.

Steam for the high pressure units is supplied by four units each rated at 325,000 lb per hr, while steam for the 225 psi system comes from eight 900-hp boilers, five 600-hp boilers, one unit rated at 125,000 lb per hr, and the waste heat boilers previously mentioned. All boilers are of bent tube design. They are variously equipped to burn coke breeze and coal on chain grate stokers, pulverized coal, or blast furnace gas, as well as any excess coke oven gas during off-peak periods.

The high pressure boilers are four-driven units, each containing 20,487 sq ft of heating surface, 7900 sq ft of superheater surface, 4015 sq ft of water wall surface and 49,500 sq ft of air preheater surface.

The two steam systems are interconnected through two pressure reducing valves, so that low pressure requirements, in excess of the supply from the topping turbines and from the low pressure boilers, may be supplied from the high pressure system.

Electric power from the three high pressure turbogenerators is stepped up to 22,000 volts and fed into a plant transmission system, with stepdown transformers at various centers of consumption. The five low pressure units feed directly into a 6900-volt transmission system. An emergency tie is maintained with the utility firm serving the vicinity with electric power. With full operations, the Weirton plant consumes approximately 45,000,000 kwhr per month.

Water for the plant is pumped from the Ohio River in quantities of about 120,000,000 gal per day. This water is drawn through traveling screens by six pumps, three rated at 22,000 gpm, two at 11,000 gpm, and one at 55,000 gpm. Except for further straining at various points, no treatment is given the general purpose water except that going to the tin mill, where a chemical clarification is used. Water from the barometric condensers at the powerhouse is subsequently recirculated to the blast furnaces, open hearth and rolling mills. Five 11,000-gpm pumps and eight 5000-gpm pumps are provided for this repumping service.

Water for boiler feed is treated in hot process lime-soda softeners, followed by pressure filters, deaerating heaters, and an auxiliary phosphate treatment into the mud drum of each boiler. Since all condensing equipment is of barometric type, boiler feed water is 100 per cent make-up.

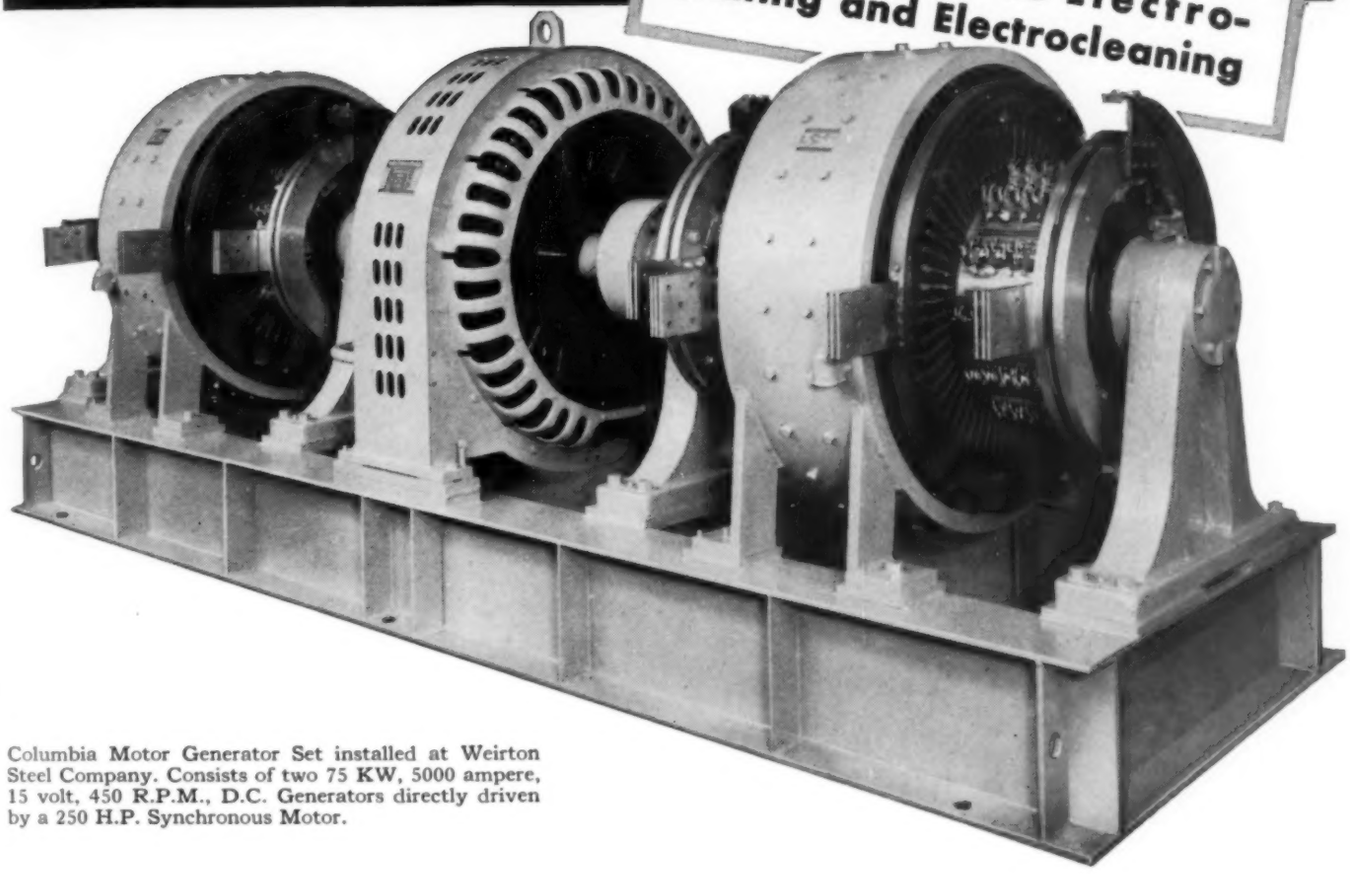
Excellent facilities for equipment repairs, as well as for a considerable amount of construction work, are provided by central machine and electric shops located near the structural mill, a welding and fabricating shop near the open hearth, and shops for pipe, sheet metal, and carpenter work. In addition, small machine shops are located at the strip mills and the tin mill.

Placed in various centers near the mills are lathes and grinders as required to service the mill rolls.

Control of quality in manufacturing processes, from raw materials to the finished products, is exercised by the metallurgical and chemical department. A modern building houses complete chemical and metallurgical laboratories. Plant laboratories are also provided at the coke plant and at the open hearth.

Get the Best WITH A "STEEL MILL TESTED" COLUMBIA LOW VOLTAGE GENERATOR

For Continuous Electro-plating and Electrocleaning



Columbia Motor Generator Set installed at Weirton Steel Company. Consists of two 75 KW, 5000 ampere, 15 volt, 450 R.P.M., D.C. Generators directly driven by a 250 H.P. Synchronous Motor.

COLUMBIA engineers have extensive experience in supplying generator equipment for many outstanding continuous strip-steel electroplating and electrocleaning installations.

Columbia Motor Generator Sets are built in sizes up to 20,000 amperes, 6 volts and up. Multi-unit sets are available with or without direct-connected excitors.

Columbia Generators are designed for easy accessibility; have frames of rolled-steel welded construction; sparkless commutation from no load to 150% load, resulting in long brush life; and are equipped with anti-friction bearings. Every unit is given rigid tests that exceed any normal operating requirement.

We invite your inquiry. Write for Bulletin IS-700 and for additional information about Columbia Motor Generator Sets.

COLUMBIA

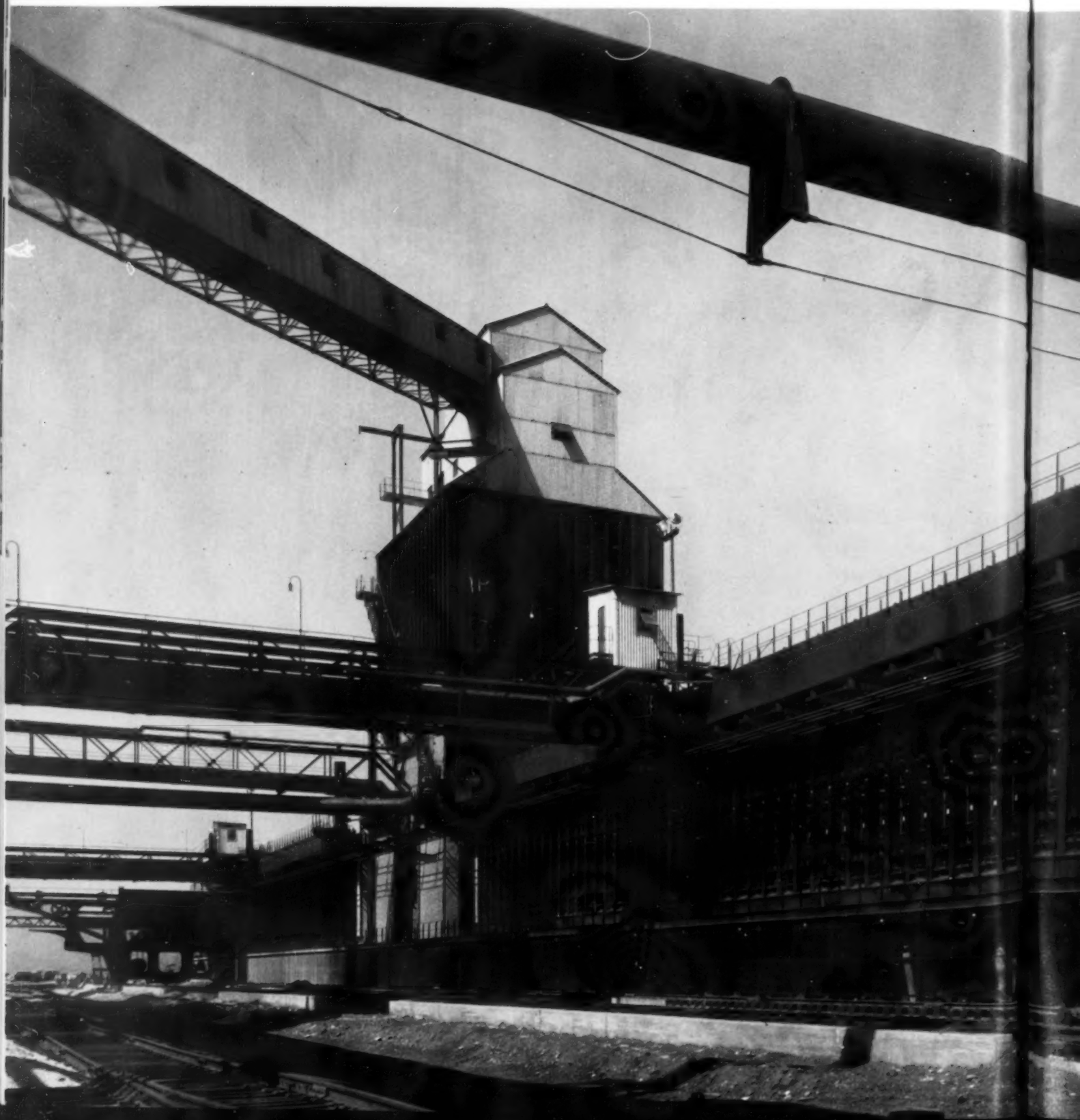
COLUMBIA ELECTRIC MFG. CO.

4519 Hamilton Ave. Cleveland 14, Ohio

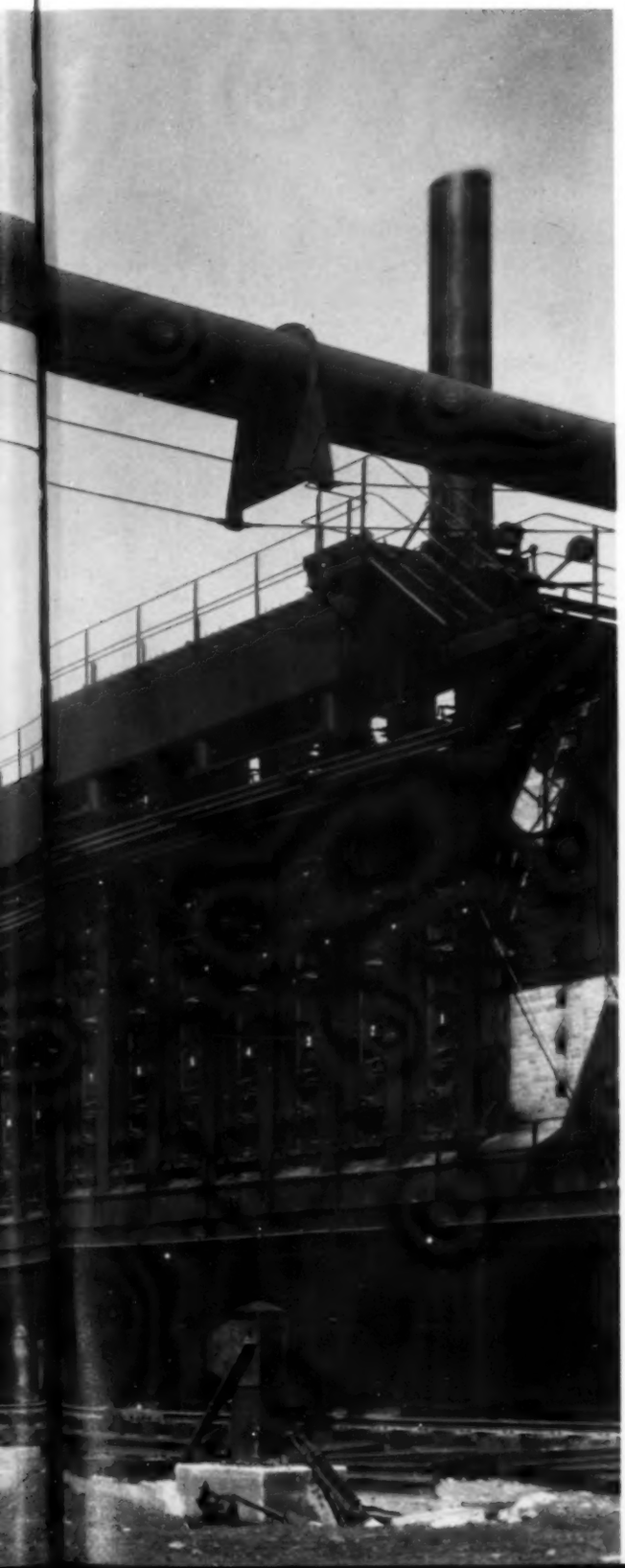
Manufacturers of

A. C. and D. C. Generators, Motor Generator Sets, Synchronous Motors, Tank Rheostats and Tong Test Ammeters

KOPPERS COMPLETES COKE OVEN PLANT EX



NT EXPANSION FOR WEIRTON STEEL COMPANY



TWO BATTERIES—106 NEW OVENS ADDED

Koppers has recently completed construction of two batteries totaling 106 Koppers-Becker Ovens for the Byproduct Coke Plant of Weirton Steel Company at Weirton, West Virginia.

These latest batteries are Koppers-Becker Under-Jet Ovens equipped with Waste-Gas Recirculation and Blast-Furnace Gas Underfiring equipment.

The first of these two newest batteries was put into operation on July 19, 1947, and the second was started on September 10, 1947. They are rated to carbonize approximately 2600 net tons of coal per day.

Koppers engineers designed and constructed the first battery of byproduct coke ovens operated by Weirton in 1922, and since that date, Koppers-Becker byproduct coke ovens have been used exclusively in this plant for the production of blast-furnace coke.

Since the erection of the 37 initial ovens in 1922, the following repeat orders were received:

1925— 49 ovens
1929— 25 ovens
1941— 45 ovens
1946—106 ovens

The first four batteries of ovens were built in line, the fourth battery being built on a unique foundation which extended out over the river bank for a considerable distance. This foundation made it possible to build the battery in line with the other three batteries, saving the investment in much duplicate auxiliary equipment.

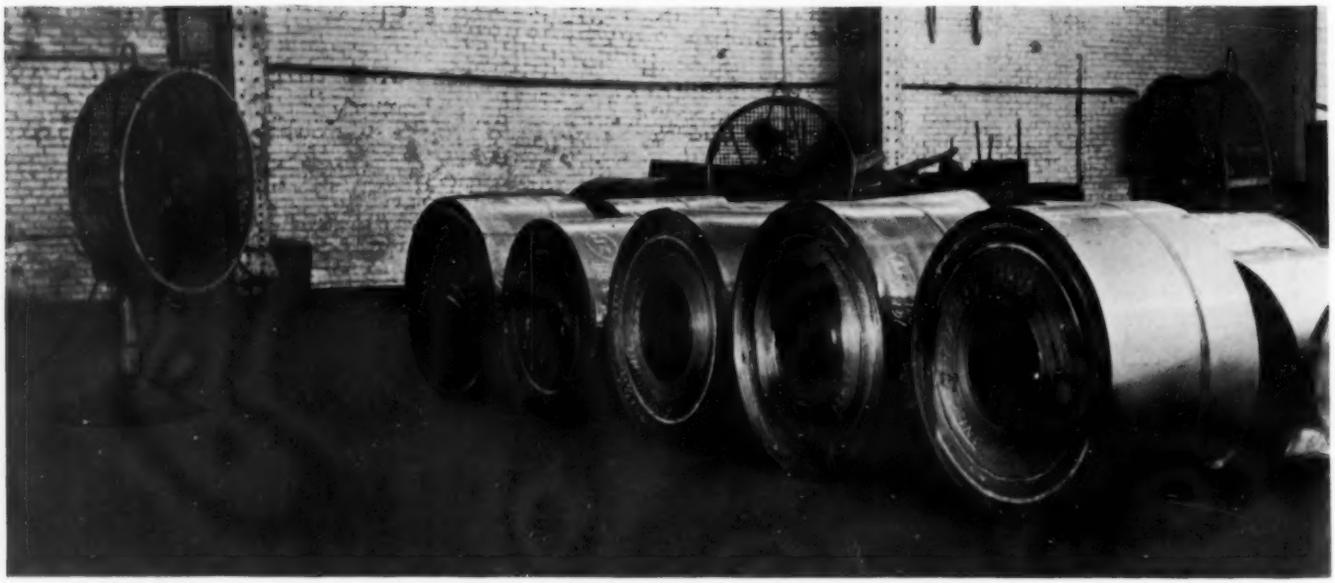
The two new batteries of ovens were built on a site adjacent to the older batteries.

The Koppers engineering staff specializes in the design and construction of the most advanced and efficient coal carbonization, material handling and gas treatment equipment.

K
KOPPERS

KOPPERS COMPANY, INC.
KOPPERS BUILDING, PITTSBURGH, PA.

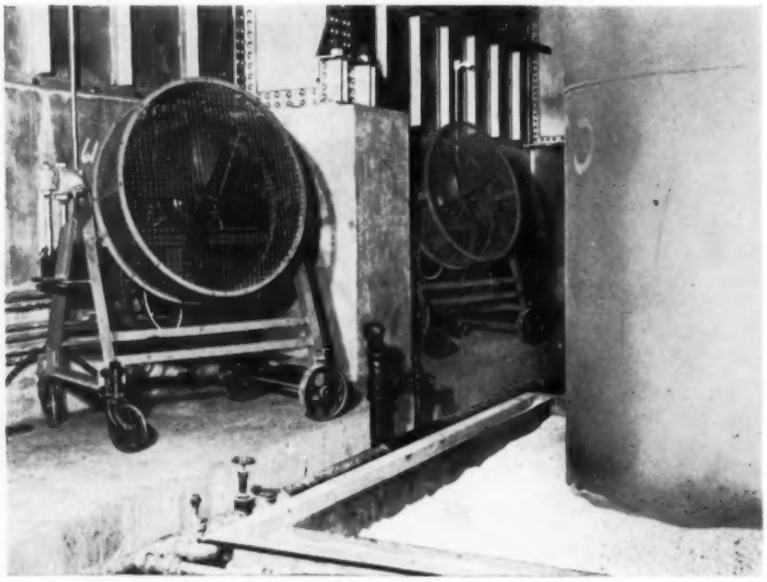
TRUFLO FANS...



Truflo series TF100 standard portable cooling fans provide a convenient method for cooling coils, speeding up overall finishing schedules.

. . . SPEED PROCESSING SCHEDULES AT WEIRTON STEEL COMPANY

Truflo series TF300W fans may be used to accelerate cooling cycles in the process of annealing.



TRUFLO PORTABLE COOLING FANS

are available in standard designs and a wide range of sizes. They are sturdily constructed for hard usage.

ALL TRUFLO FANS are designed and built to put air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per hp. Strong steel frames stand up longer. Rocket wire guards protect men against injury.

KEEP PRODUCTION MOVING IN YOUR PLANT WITH TRUFLO FANS

WRITE FOR ILLUSTRATED LITERATURE.

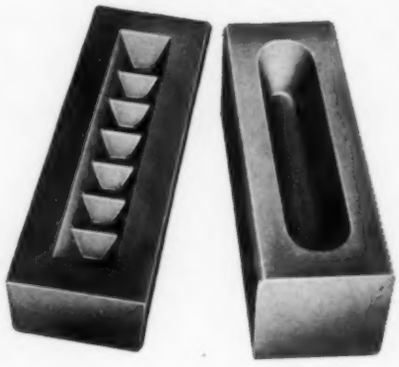
TRUFLO FAN COMPANY

554 MAIN STREET HARMONY, PA.

PORTABLE COOLING FANS
CRANE CAB FANS - WALL FANS
EXHAUST FANS - BLOWERS
ROOF VENTILATING FANS
PENTHOUSE FANS

How to get CLEANER METAL

USE "National" over-metal and pig molds!



Over-metal and pig molds made of "National" electric furnace graphite produce cleaner ingots faster and more economically. Graphite is immune to thermal shock, insoluble, not wet by molten metal, easy to machine, has high thermal conductivity, and lasts indefinitely. This means ingots chill rapidly, won't stick in the mold, are free from contamination and smooth in finish. No mold wash necessary. Quick chill cuts floor space and number of molds to the minimum.

STEEL SCRAP IS URGENTLY NEEDED. BE SURE TO TURN YOURS IN!

USE "National" fluxing tubes and pyrometer sheaths!

"National" graphite fluxing tubes, for purification of hot metals, give unusually long life and will not contaminate the metal. They are heavy-walled, easily threaded, will not fuse or dissolve, and are not attacked by Nitrogen, Chlorine, or the rare gases. Stocked in 2" OD by ½" ID by 2', 3', 4½', 6', and 9' lengths. "National" graphite thermocouple sheaths are similar in construction to the fluxing tubes, except that they are blind end. Both products possess all the advantages of pure electric furnace graphite.

USE "National" skimmer floats!

"National" graphite skimmer floats prevent oxidation, hold back slag and dross, and will not contaminate the casting metal. They are fitted with a convenient lifting hole for easy handling and may be used over and over again. Made of pure electric furnace graphite—no foreign bond—these floats will not spall or crack. Stocked in diameters from 3" to 9" for use with crucibles #5 to #100 inclusive. "National" skimmer floats pay for themselves!

The term "National" is a registered trade-mark of

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

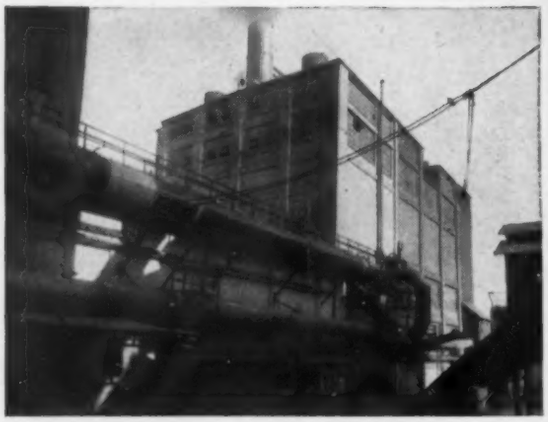
30 EAST 42nd STREET, NEW YORK 17, N. Y.

Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

These products sold in Canada by

Canadian National Carbon Company Limited, Toronto 4, Canada

Chessboard and Jigsaw Methods



In 1940 Dravo constructed a power plant addition, housed in the two left bays, to supplement the boiler capacity of the original plant.

View of new Weirton power plant, completed by Dravo in 1947. Note how railroad tracks limited construction space.

Expedite Power Plant Construction

Weirton Steel Company power plant

completed by Dravo without interruption of work schedules

Here, at Weirton Steel Company, were all the elements to challenge Dravo Power Plant Specialists:

(a) power plant expansion plans with limitations on construction space

(b) equipment installations complicated by rail traffic, water supply lines, coal- and ash-handling systems

(c) a twenty-four-hour mill operation which could not be interrupted

But chessboard and jigsaw methods are no hindrance to Dravo Power Plant Specialists. Dravo engineers are accustomed to applying unique construction techniques—are trained by industrial experience to integrate work schedules with mill operations.

Without any interruption of steel production, without any changes in railroad operation, main plant water lines were moved to temporary locations then into a permanent underground tunnel after foundations were prepared. Coal-handling and ash-handling installations were routed from place to place, always functioning to keep steel moving. Each step in this elaborate operation was so carefully coordinated that boiler installations were completed in record time in spite of frequent construction delays.

When it was finally erected, the building housed these major equipment items neatly fitted into the irregular shaped, vertical power plant:

(a) one 325,000 lbs. per hour boiler, operating at 800 psi. and 800° at superheater outlet

(b) combustion control to integrate fuel feed with steam demand

(c) forced and induced draft fans

(d) boiler feed and booster pumps

(e) heat exchanger

(f) coal-handling and ash-handling equipment

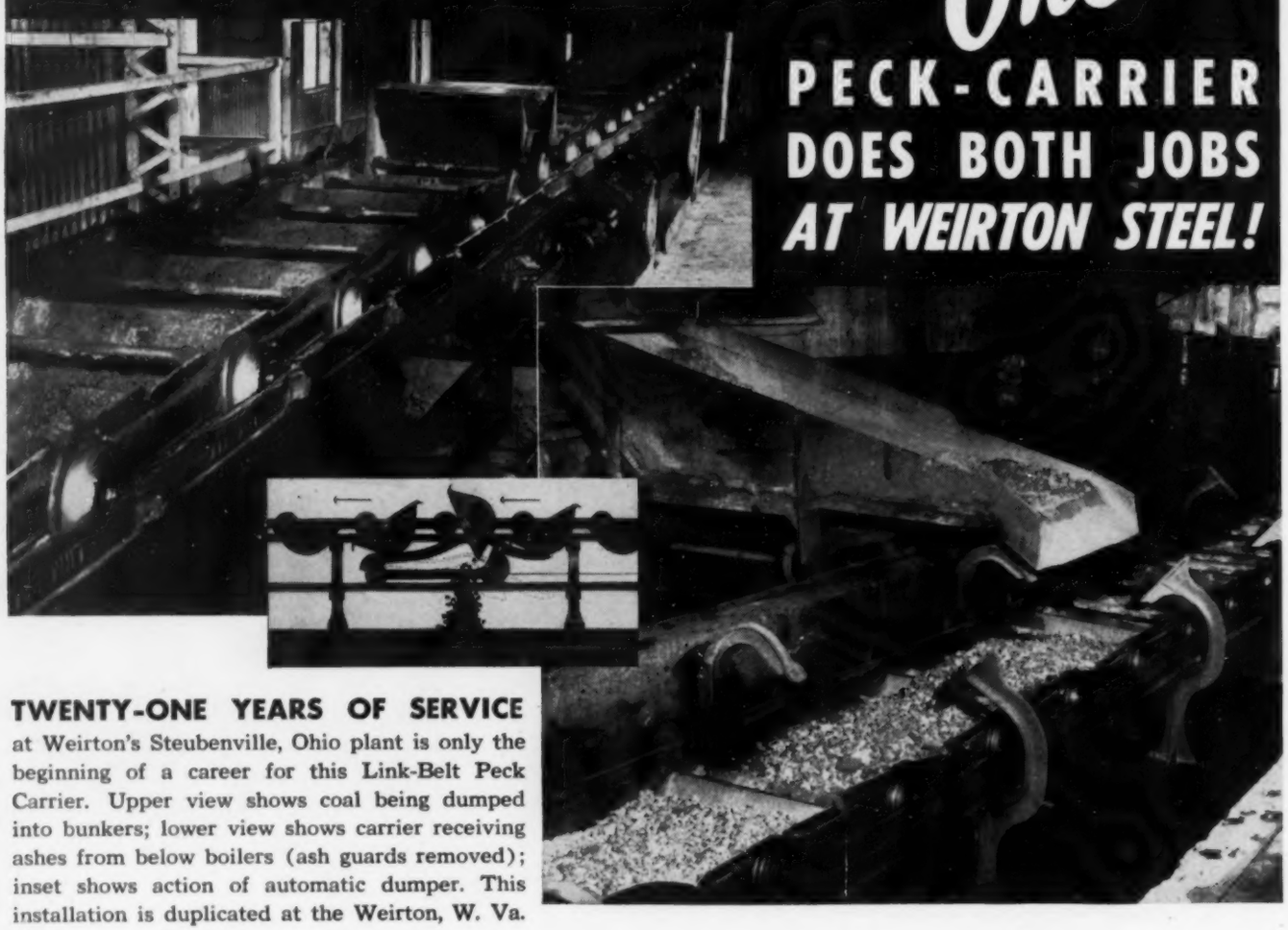
Here again Dravo experience in the engineering construction of boiler and power plants, and in major equipment installations, proved its worth just as it had in previous Dravo installations at Weirton Steel Company. This Dravo experience can save you time and space and prevent work interruptions—relieve your engineering and supervisory staffs of many burdens when you construct, expand or modernize your boiler and power facilities. It's never too early to call in Dravo Power Plant Specialists.

DRAVO CORPORATION

PITTSBURGH · PHILADELPHIA · CLEVELAND · NEW YORK · DETROIT

Power and Boiler Plants · Pumping Stations · Power Plant and Contractors' Equipment · Direct-Fired Heaters Industrial Heating and Ventilating · Bridge Substructures · Docks · Pump Houses and Intakes · Mill Foundations Locks and Dams · Shafts, Slopes and Tunnels · Towboats and Barges · Coal and Ore Bridges · Cranes and Derrick Boats · Crane Cab Coolers · Open Steel Flooring · Concrete Aggregates · Inland River Transportation

COAL IN—ASHES OUT--One PECK-CARRIER DOES BOTH JOBS AT WEIRTON STEEL!



TWENTY-ONE YEARS OF SERVICE at Weirton's Steubenville, Ohio plant is only the beginning of a career for this Link-Belt Peck Carrier. Upper view shows coal being dumped into bunkers; lower view shows carrier receiving ashes from below boilers (ash guards removed); inset shows action of automatic dumper. This installation is duplicated at the Weirton, W. Va. plant.

VERSATILE ••• SIMPLE ••• ECONOMICAL

For coal, ashes, coke, ore, cement clinker and similar materials of abrasive nature or high temperature, the Peck overlapping, pivoted bucket carrier offers the lowest cost, most dependable type of conveying. The load is *carried*, not dragged, in pivoted buckets, which always remain horizontal except when dumping. Carrier unit elevates and conveys in a continuous flow, horizontally, vertically or on an incline, in any direction within one vertical plane.

Malleable buckets and chains resist corrosion and permit larger bearing area, without excessive chain weight.

Low travel speed, simple drive and large suspension rollers save power. Used entirely within boiler room walls, without cutting walls or roof, or erecting penthouses.

Up-to-date improvements and standardization of individual units and assemblies reduce installation and operation costs and permit flexibility in layout.

More than 50 miles of Peck Carrier are reducing materials handling costs in many kinds of plants. Learn how its features can save costs in your plant. Write for Book No. 1720 with full details.

LINK-BELT CONVEYORS

PREPARATION EQUIPMENT . . . POWER TRANSMISSION MACHINERY

Link-Belt boiler house equipment including conveyors, elevators, crushers, weigh larries, is aiding the efficient operation of power plants for every type of industry. For information, get in touch with our nearest office.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities. 11,105

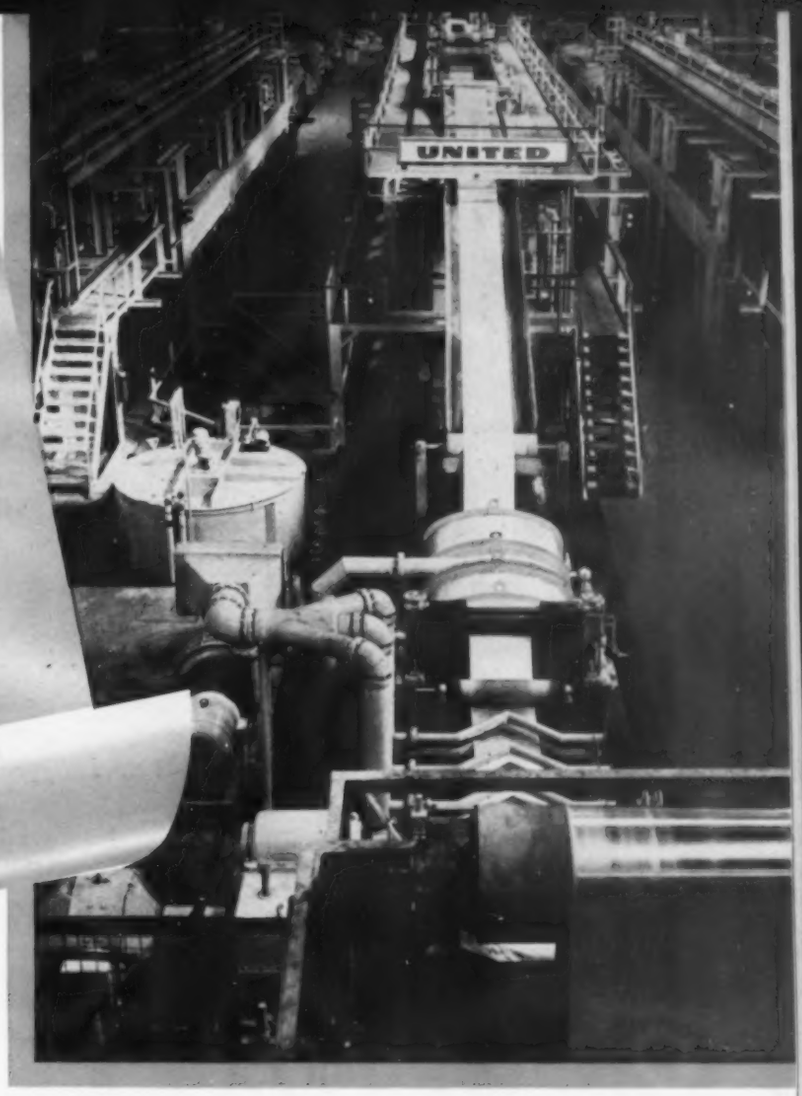
THE WORLD'S *Fastest*

CONTINUOUS ELECTROLYTIC PLATING LINE

40 to 50 times Faster

THAN CONVENTIONAL HOT DIP METHODS

Saves Critical Material



Three-decked units housing plating cells of three separate Continuous Electrolytic Plating Lines—Weirton Steel Company.

Developed by United Engineering and Foundry Company, Pittsburgh, Pa., in collaboration with the Hanson-Van Winkle-Munning Company of Matawan, N.J., this speediest of all Continuous Electrolytic Plating Lines takes strip steel in coil form from Cold Rolling Mills, side trims, cleans and pickles; then deposits tin on the strip electrolytically, producing tinplate at speeds up to 1300 ft. per minute—40 to 50 times *faster* than by hot dip plating.

In the application of zinc coatings, the electrolytic process produces a tighter bond between zinc and steel than can be obtained by conventional hot dip methods.

Several of these lines in daily operation are delivering consistently high quality tin and zinc plated strip at peak production with minimum interruption for adjustment or maintenance.

An installation now, in your plant, may not only solve vexing cost and production problems, but assure you definite competitive advantages.

We invite your inquiry.

UNITED ENGINEERING AND FOUNDRY COMPANY
PITTSBURGH, PA.

HANSON-VAN WINKLE-MUNNING COMPANY
MATAWAN, N. J.

DURCO EQUIPMENT UNEXCELLED FOR RESISTING CORROSION in the steel mill

Weirton Steel Company uses Durco—Pumps, valves, steam jets, fans and drain pipe to handle severe corrosives *economically.*

Although Durco equipment is made in ten standard alloys, the following withstand most of the corrosives in a steel mill.

DURIRON—High Silicon Iron for Sulphuric Acid & Plating Solutions.

DURICHLOR — High Silicon-Moly Iron for Hydrochloric (Muriatic) Acid.

DURIMET 20 — High Alloy Stainless Steel — Sulphuric Acid, Plating Solutions, Tar by-products, Hydrofluoric Acid.

CHLORIMET 2—Nickel-Moly—Hydrochloric and Sulphuric.

CHLORIMET 3—Ni—Mo—Cr—Hydrochloric and Sulphuric.

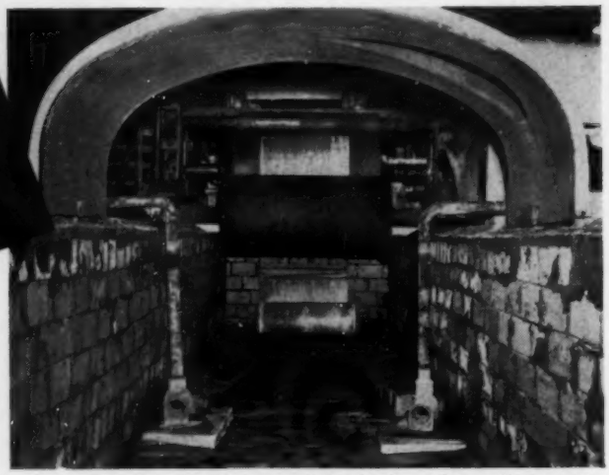
The following table tells you where and what Durco equipment is used in the steel industry. For complete information on a specific product write for the bulletins listed.

	Equipment	*Alloys*	*Bulletin No.*
Pickling (all types)	Dancer Rolls	Duriron and Durimet 20	11, 112
	Steam Jets	Duriron and Durimet 20	1804
	Fans (small)	Duriron	1102
	Pumps	Duriron and Durimet 20	815
	Valves	Duriron and Durimet 20	610, 640
	Tank Outlets	Duriron	1805
	Siphons	Duriron	1820
	Pipe & Fittings	Duriron	704
	Sanitary Drain Lines	Duriron	703
Scrubbing	Pumps (caustic soda)	Durimet 20	815
Electrocoating (all types)	Pumps	Duriron, Durichlor Durimet 20	815
	Valves	Duriron and Durimet 20	610, 640
	Sanitary Drain Line		703
	Steam Jets	Duriron	1804
Acid Unloading and distribution	Pumps, Valves	Duriron, Durichlor and Durimet 20	815
Spent Acid Neutralization and disposal	Pumps	Duriron and Durimet 20	815
	Valves	Duriron and Durimet 20	610, 640
	Sanitary drain Line	Duriron	703
Laboratories	Sinks, fans, sanitary drain line	Duriron and Durichlor	703
By-product Coke	Pumps, Valves Special equipment	Duriron Durichlor and Durimet 20	815, 610 11, 50, 112

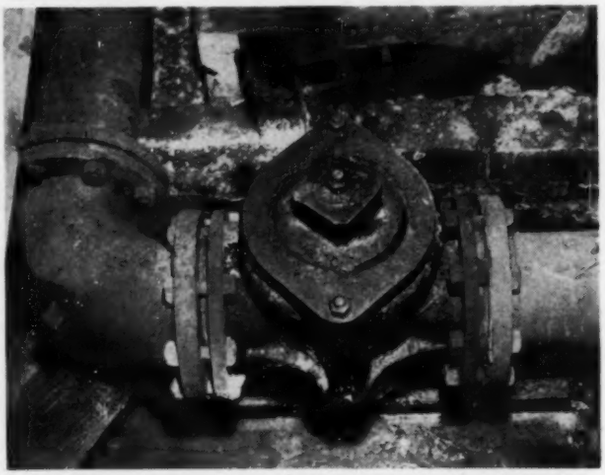
THE DURIRON CO., INC.
DAYTON 1, OHIO
Branch Offices In Principal Cities

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

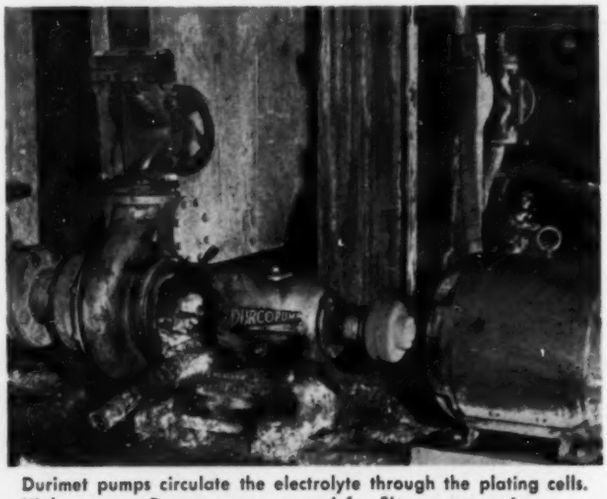
How Durco Equipment Helps In The Production of WEIRITE (Electrolytic Tin Plate) and WEIRZIN (Electrolytic Zinc Plate).



Duriron steam jets heat and agitate the hot dilute sulfuric acid in the etch tank.



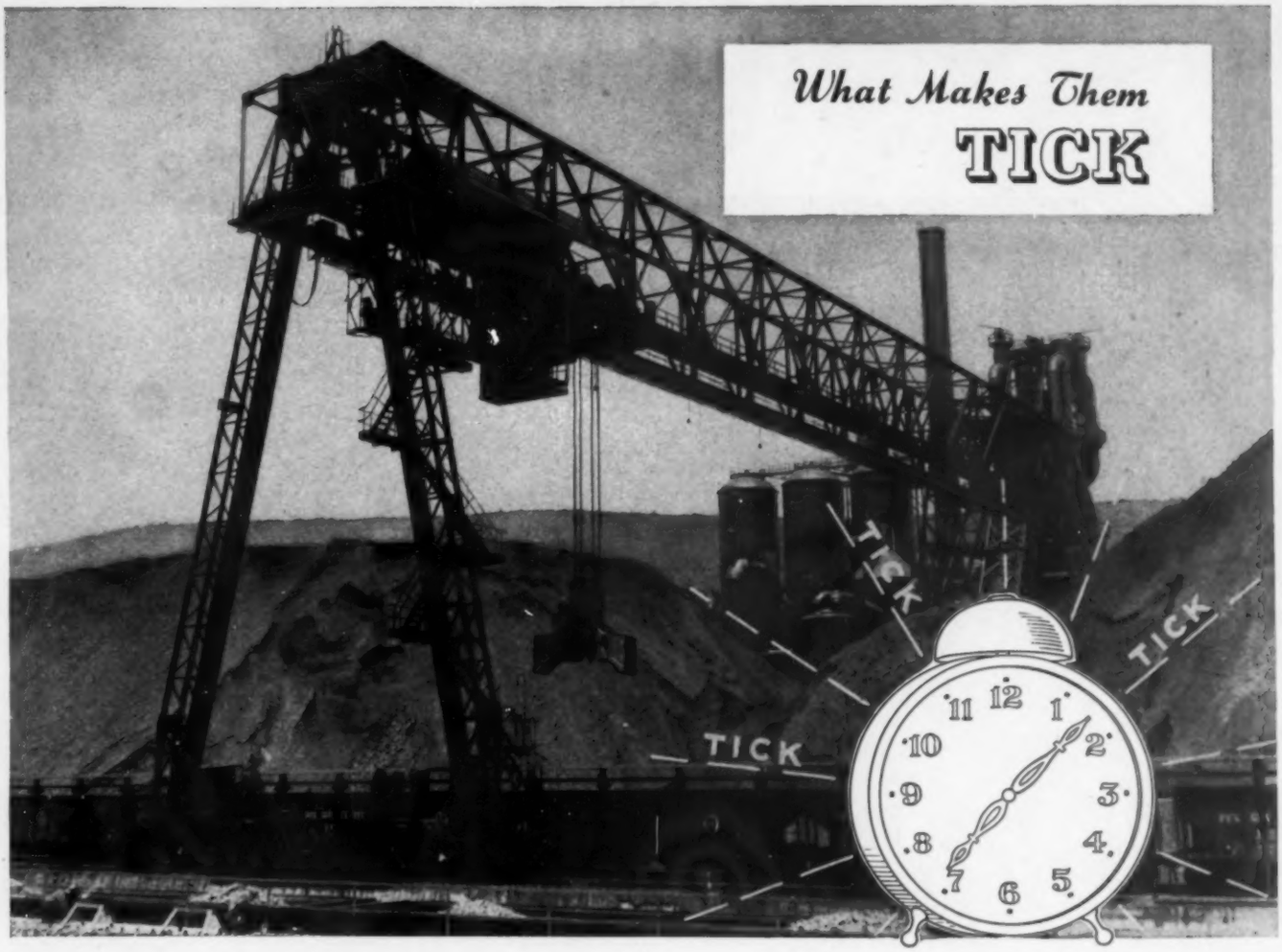
Duriron plug valves control hot acid in outlet line from etch tanks.



Durimet pumps circulate the electrolyte through the plating cells. High pressure Durcopumps are used for filter press services.

In addition, Duriron Steam Jets, Plug Valves and Durimet Guide Rolls and Plug Valves are used in Weirton's Strip Mill and Sheet Mill. Duriron exhaust fans and a Duriron drainage pipe system are installed in the metallurgical laboratory.

DURCO Adv. 65-GM



at WEIRTON STEEL COMPANY?

When you visit the Weirton Steel Company, watch that man 90 feet above the ground, operating a Heyl & Patterson designed, built and erected Traveling Man-Trolley Ore Bridge. This bridge together with another H&P ore bridge handles the ore for Weirton's 3 blast furnaces.

Ask the operator of the Ore Bridge . . . ask the maintenance men who are responsible for blast furnace production . . . what makes this giant machine tick?

They have been living at Weirton with this H&P Ore Bridge since 1941 and with the other H&P Ore Bridge since 1926. They know what makes them tick. They'll tell you about their complete dependability for stocking, transfering and reclaiming iron ore . . . about low maintenance cost . . . ease of operation . . . sturdiness . . . weatherproofing . . . automatic rail clamps . . . and ever so quiet operation.

All the Way from Design to Erection

Ore Bridges
Railroad Car Dumpers
High Lift-Turnover-Rotary
Coal Preparation Plants
Coal & Coke Handling Equipment
Boat Loaders and Unloaders
Rotary Mine Car Dumpers
Coal Crushers
Coal Storage Bridges
Car Hauls & Boat Movers
Bradford Breakers
Refuse Disposal Cars
Thorsten Coal Samplers
Kinney Car Unloaders
Pig Iron Casting Machines

Heyl and Patterson has been designing, building and erecting Heavy Bulk Materials Handling Equipment since 1887. Ask an H&P Engineer to give you the benefit of these 61 years of experience.

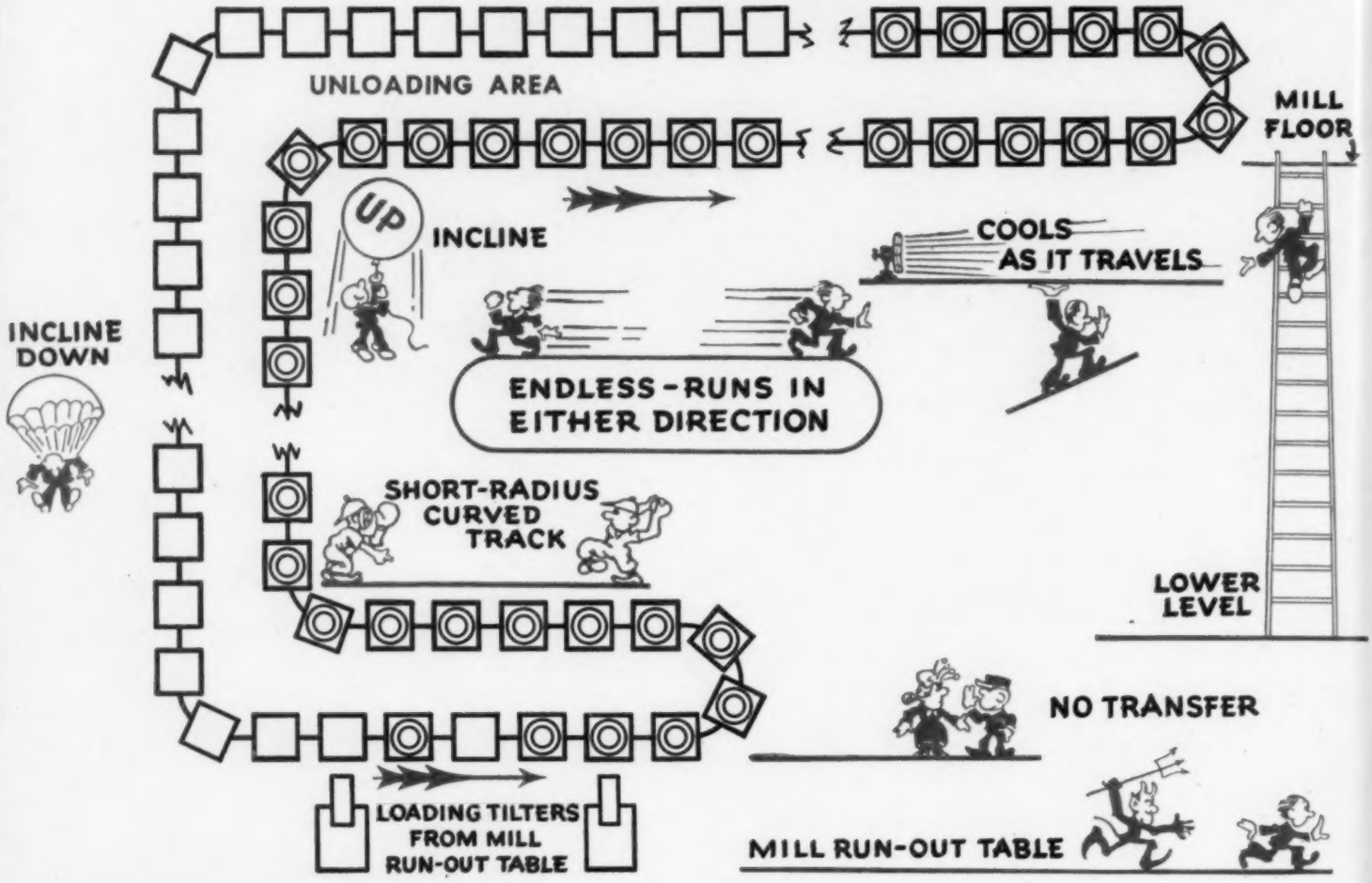
Heyl & Patterson, Inc.

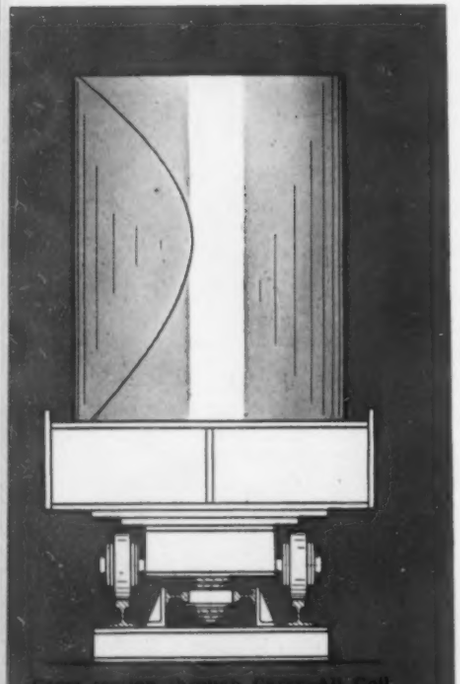
"SINCE 1887"

55 WATER STREET · PITTSBURGH 22, PA.

A Steel Mill's Dream

Becomes reality . . .





Cross section through Carry-All Coil Conveyor, designed for use where two parallel chains cannot be used.

● *Universal Performance Features Characterize Palmer-Bee Hot Coil Conveyor* . . . Details enumerated and illustrated on this page furnish proof of a universal versatility which heretofore existed only as a steel mill's dream.

Actual facts follow . . . It travels in a horizontal plane and is endless . . . It is one continuous conveyor which receives hot coils from coilers, passes through the cooling period and delivers without transfer to any place in the mill . . . By means of short radius curved track it makes all right angle and any other horizontal turns without creating the slightest movement to the coils on the car . . . The conveyor consists of 4-wheel cars, spaced and attached to a single endless chain . . . Car wheels and rollers are equipped with anti-friction bearings . . . Car axles are radial with the center of the curve when passing around a horizontal turn, and the wheels run free . . . Takeup for slack in the chain is automatic.

This Palmer-Bee conveyor is now in operation . . . Other conveyors of similar type are in the course of construction.

...A Hot Coil Conveyor

with New—Remarkable Features

Reality . . . The above photo shows a 720'-0" Single Chain, Hot Coil Cooling Conveyor in Action . . . Built to carry a load of 1700 tons . . .

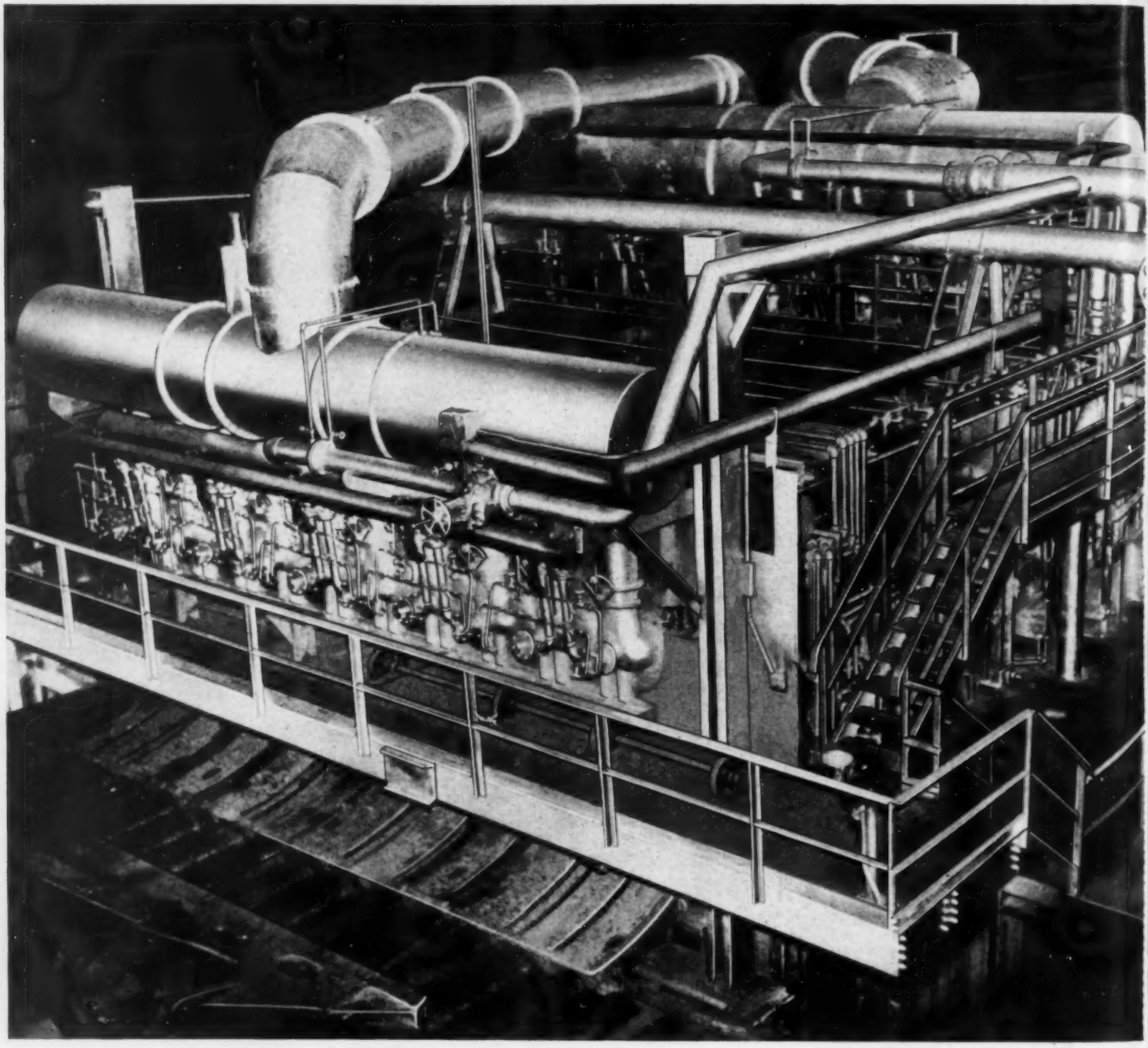
The conveyor is receiving coils from the mill run-out table by means of two retractable down-enders which operate alternately and keep every car loaded . . . The down-ender in the foreground is placing a coil on the conveyor, and the one in the background is ready to receive a coil as it is stripped from the mandrel on which it is wound . . . Coils on the opposite side, after passing through a 50- to 60-minute period in the cooling zone, and turning a 180 degree curve in the far background, are unloaded from the conveyor . . . This is accomplished by means of a machine identical with the loader . . . The action, however, is in reverse.

Palmer-Bee Exclusives . . . The Coil Conveyor Design and the Method of Loading and Unloading.

PALMER-BEE COMPANY

DETROIT 12, MICHIGAN

The World's Largest



World's Largest Slab-Heating Furnace in Weirton Steel Company's Hot-Strip Mill

AMERICAN ARCH

1430 Park Building, Pittsburgh, Pa.

REPRESENTATIVES: BIRMINGHAM • CHICAGO • CINCINNATI

Slab-Heating Furnace

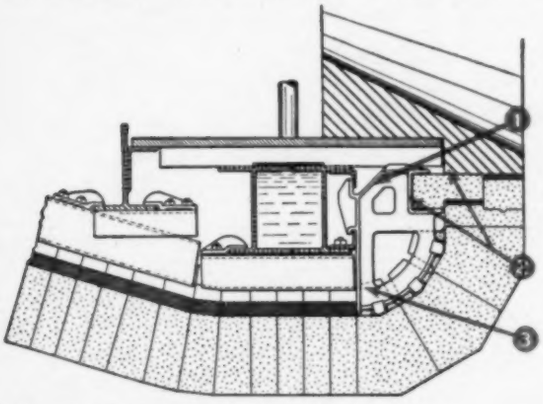
has

AMERICAN SUSPENDED ARCH ROOF

This giant furnace in Weirton's hot-strip mill, at Weirton, West Virginia, has an American Suspended Arch Roof and Nose Construction. After nearly three years of continuous service, a single cent has yet to be spent for maintaining the suspended roof or nose.

All other furnaces in this plant, with suspended arches, are of American Arch construction.

Section of typical modern American nose construction



1 Load-bearing support tile
2 Ship-lapping expansion joints
3 Full effective burning depth of tile is utilized
Tile is of correct thickness

In this furnace the Suspended Nose Construction is of the most modern American Arch design.

The tile is of the correct thickness for the most satisfactory machine pressing, insuring uniformity of quality throughout. For maximum strength, the tile is made nearly the same thickness at the supporting end as in the main body.

Replacement of nose tile does not require the removal of any bolts.

The burner wall above the nose is so supported that the nose tile is relieved of any strain from the weight of the wall. This is accomplished without sacrificing any of the effective burning depth of the tile.

Finally, ship-lapping expansion joints prevent any danger of the flame reaching the supporting castings.

COMPANY, Inc.

INDUSTRIAL DEPARTMENT

60 East 42nd Street, New York, N. Y.

CLEVELAND • DENVER • DETROIT • LOS ANGELES • PHILADELPHIA

In 1926, Weirton Steel Co. installed the largest single unit hot process water softener in the world—a Cochrane 160,000 GPH unit—at their Weirton, W. Va., plant to treat 100% makeup for 225 lb., 525° F. boilers. So perfectly has this system operated that a duplicate was ordered for their new boiler plant, even though boiler pressures are now 850 lb. and the temperature 825° F. While capacity has been doubled, load can be swung from one unit to the other, if necessary. Installation has been completed, as shown by the above photograph, and is giving great satisfaction. A 600,000 lb./hr. Cochrane Deaerator has also been installed.

COCHRANE CORPORATION · PHILADELPHIA, PA.

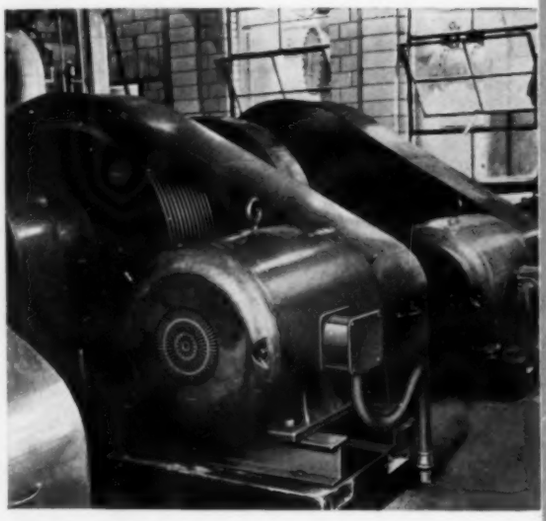
PIONEERS IN FEEDWATER CONDITIONING

Write for complete details of this installation and a copy of Publication No. 3000

Cochrane

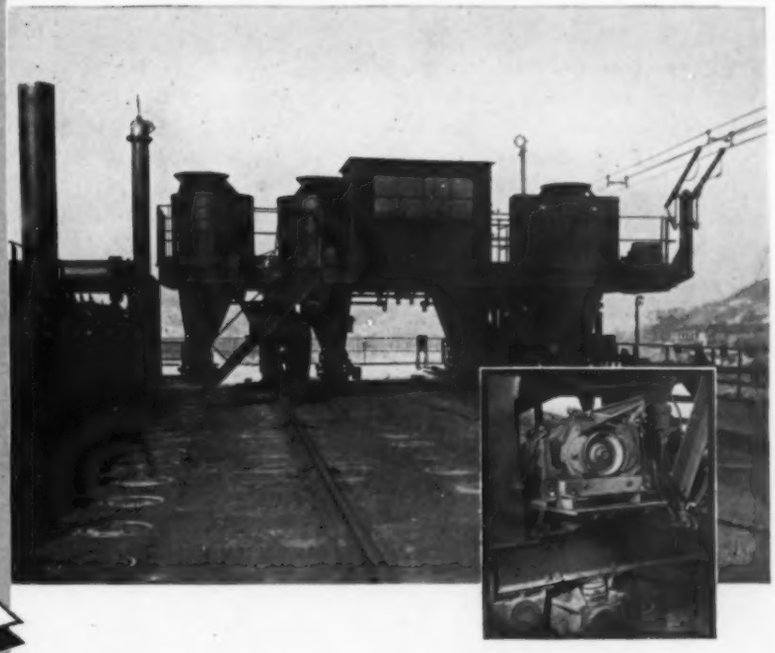
DEAERATORS · SOFTENERS · FILTERS · VALVES

Wagner
TRANSFORMERS MOTORS and INDUSTRIAL BRAKES at WEIRTON



Wagner Electric Corporation is proud to be the maker of products that aid in the production of the country's most essential material, steel. At Weirton Steel Company, Wagner transformers help supply power to operate the plant's equipment; Wagner motors drive blowers, pumps, compressors and other apparatus; and Wagner industrial brakes provide safe control of cranes and coke-oven machinery.

At Weirton, as well as in all types of manufacturing plants throughout the world, Wagner products are serving industry faithfully, upholding the Wagner reputation for quality and dependability.



Wagner Electric Corporation
EST. WE 1891

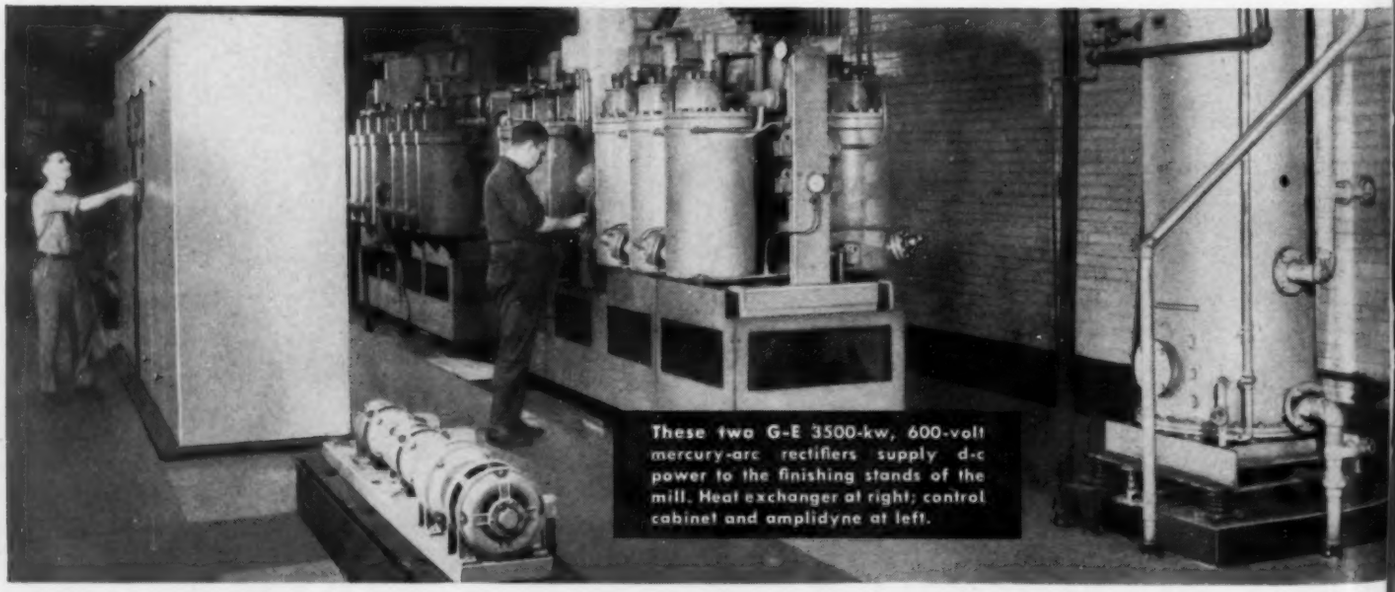
G48-3

Wagner Electric Corporation
6483 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.

A Report on Steel

HOW G-E EQUIPMENT HELPS

Below are the first mercury-arc rectifiers installed in the United States to supply power to the main roll drives of a hot-strip mill. Installation of these two 3500-kw rectifiers in 1946 made possible the addition of more horsepower on the main drives without an increase in the number of generators—*and* insured a more economical operation than would have been possible with additional generators.



These two G-E 3500-kw, 600-volt mercury-arc rectifiers supply d-c power to the finishing stands of the mill. Heat exchanger at right; control cabinet and amplidyne at left.

Mill Modernization

General Electric Engineering and Equipment Make Large Contribution to Weirton's 66-inch Hot-strip Mill

A complete change-over of a 48-inch continuous hot-strip mill in 16 days' time! That's a record set by the Weirton Steel Co. of West Virginia—another example of progress and modernization in our great steel industry.

Partner with Weirton in this project was General Electric Co., whose specialists in electrical equipment for the steel industry teamed up with the Weirton engineers to do the job. The 48-inch mill—the world's first completely continuous 4-high wide-strip mill—was changed to a 66-inch mill, with an increased capacity of 50% over the original mill's production of 90,000 tons per month.

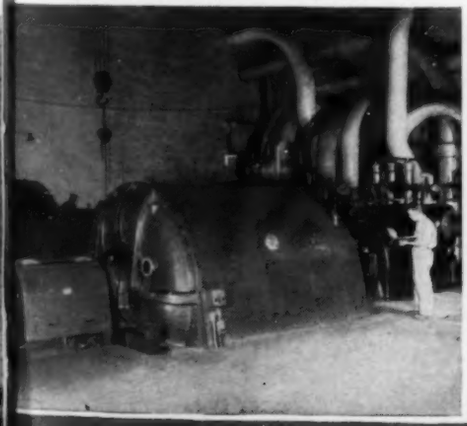
To do this, General Electric engineers, in cooperation with Weirton, redesigned the mill's entire electrical system. When plans were completed and equipment was available, installation was completed in 16 days. The result is a mill which operates at a minimum rate of 1,500,000 tons annually. The hot-strip steel from this mill is the best that engineering knowledge and operating skill can produce.

Coupled with the engineering skill of G.E.'s specialists is the Company's ability to manufacture every electrical component for the steel industry—from the smallest relay to the largest drive. For this reason, General Electric has enjoyed a close and increasingly active partnership with the steel industry for years. The notable contributions made by G.E. to this Weirton installation are typical of the results of this partnership.

Below are pictured a few of the G-E components which make the operation of the Weirton mill so outstanding. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

KEEP WEIRTON STEEL PRODUCTION HIGH!

Weirton's 10,000-kw G-E turbo-generator (one of six G-E units powering all mill operations) consists of a steam turbine coupled to an a-c generator. In one month, this turbo-generator carried an average of over 12,500 kilowatts. Its record: 97.58% availability over ten years.

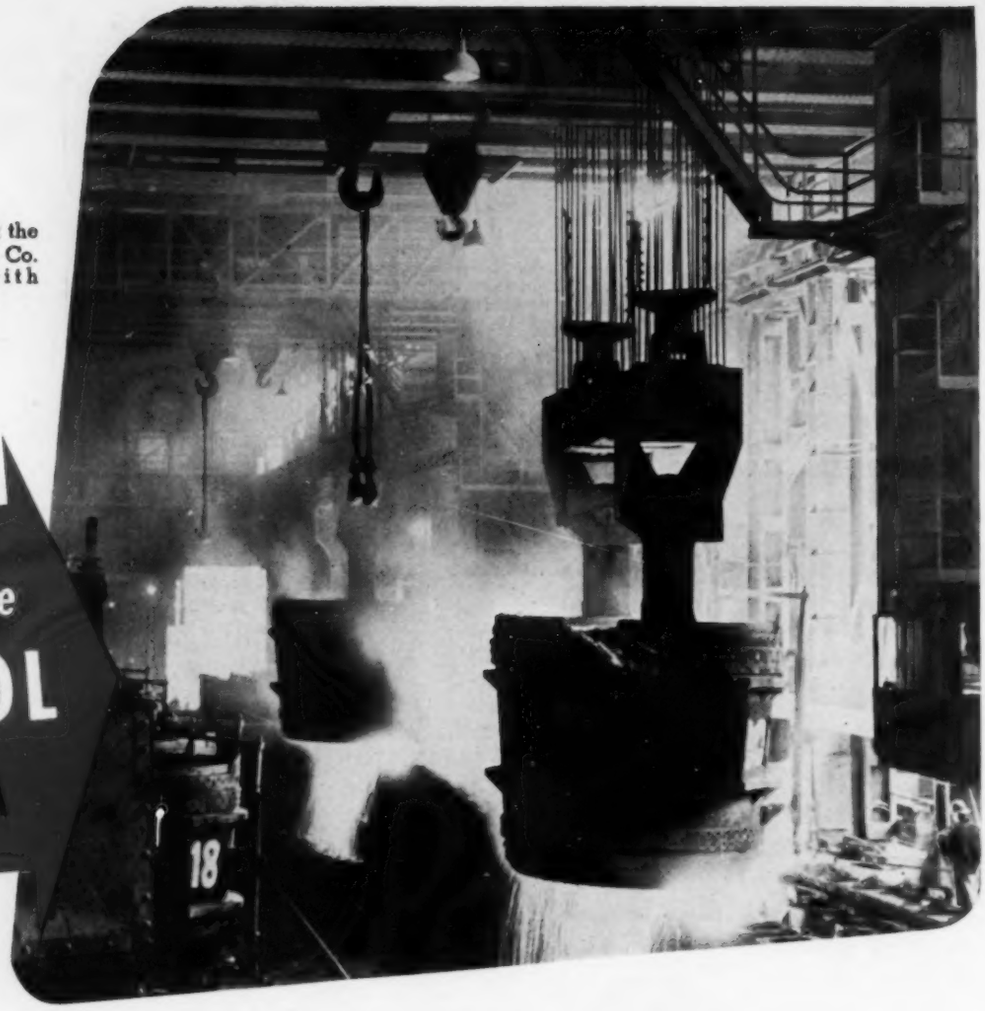


Below is the mill's motor room with its eight huge G-E d-c motors delivering a total of 23,000 hp to the six stands. The motors on the first two stands are the original four (total of 9000 hp); the others (total of 14,000 hp) were added when the mill was enlarged to 66-inch capacity.

General Electric metal-enclosed switchgear serves in many locations in the Weirton Steel Company's plants. Illustrated below is a unit with fourteen 600-volt, electrically-operated air-circuit breakers which distributes 550-volt a-c power in the mill's substation.

GENERAL ELECTRIC

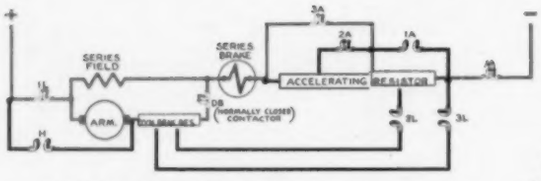
659-50



Ladle cranes at the Weirton Steel Co. equipped with EC&M Control.

Ladle Crane CONTROL by EC&M

has these outstanding advantages

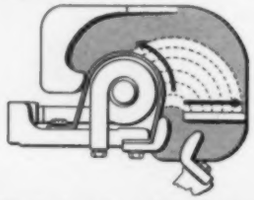


EC&M's HOIST Controller uses these connections on first point lowering for fast brake release.

EC&M's Simplified, Safe Dynamic Lowering Circuit for hoist motions gives quick response—the operator, too, has complete control (from the master switch) of the load in the lowering direction.

EC&M Magnetic Contactors operate on the *LINE-ARC* principle - there is no destructive burning of arc shields—contacts operate cool—maintenance is reduced.

EC&M TIME - CURRENT Relays automatically control acceleration (according to the load) to give fast, safe operation. There's only one adjustable relay for plugging, too.



LINE-ARC design transfers the arc from the contact-tips in 1/500th second; centers the arc between the arc shields.

Only *one* moving part in the TIME-CURRENT acceleration relay—magnetically centered in its short movement.

When Buying Cranes, Specify EC&M Control

THE ELECTRIC CONTROLLER & MANUFACTURING CO.

2698 EAST 79th STREET CLEVELAND 4, OHIO

MICROMAX
Does Many Jobs for Weirton Steel Co.

Electrolytic Tinning Line Uses This Micromax Pyrometer

Internal and Recuperator Temperatures of an S. C. Co. Slab Furnace Are Controlled by These Micromax Instruments

Temperature of Hot Dip Galvanizing Bath is Controlled by These Micromax Pyrometers

The three processes pictured above are typical of the great variety of operations controlled by Micromax pyrometers at Weirton Steel Company.

Micromax Equipment has many features which make it suitable for large or small plants, but probably the most important is its versatility. In its Control function, Micromax can regulate any controllable process, at any temperature from freezing air to boiling steel. In its "informing" function, Micromax supplies record charts in round or strip-form, indicates temperature on either of two types of scale, and can "wink, ring or holler" as warning in an emergency. It can combine functions as you wish — can indicate, record and control; indicate and record only; indicate and control only; or it can just control, though the trend is to the more complete operations.

In providing fully automatic regulation, Micromax offsets the effect of changes in ambient temperature, flow of work, and other upsetting factors with extreme promptness and accuracy. A large part of Micromax success rests not only on what it does, but also on the sensitive and dependable way in which it operates.

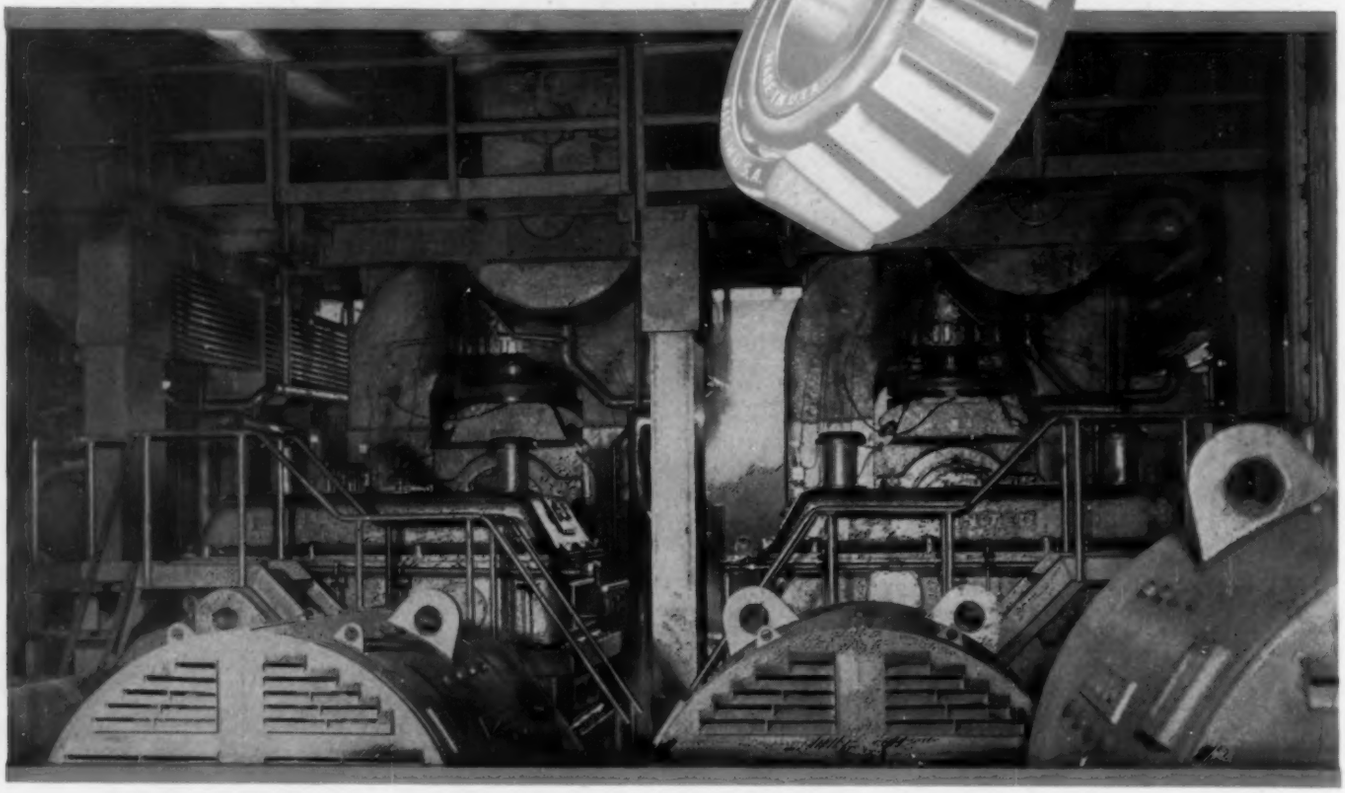
For further information, write to Leeds & Northrup Company, 4942 Stenton Avenue, Philadelphia 44, Pa.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · AUTOMATIC CONTROLS · TELEMETERS
HEAT-TREATING FURNACES

Jrl. Ad N-33-680(1)

WEIRTON "MILE A MINUTE" MILL USES TIMKEN® BEARINGS



Center of interest at the plant of the Weirton Steel Company, Weirton, W. Va., is the new United 4-high, #6 mill, 5 stand, 21" x 53" x 48" cold tin plate mill, one of the fastest ever built.

This is the first high speed mill to be equipped with individual drives and roller bearings.

Timken Bearings are used in the following major equipment at Weirton with a long record of successful accomplishment:

No. 1 mill, 16" and 38¼" x 48"; 4-high cold tin plate mill, 4 stands. Back-up, work rolls and screwdowns.

No. 3 mill, 16" and 38¼" x 42"; 4-high cold tin plate mill, 4 stands. Back-up, work rolls and screwdowns.

No. 4 tandem mill, 19" and 48½" x 36"; 4-high cold mill, 4 stands. Work rolls, drives, pinion stands and screwdowns.

No. 5 tandem mill, 19" and 45" x 36"; 4-high cold mill, 4 stands. Work rolls, drives, pinion stands and screwdowns.

No. 6 tandem tinplate mill, 21" and 53" x 48"; 4-high, 5 stands. Work rolls, drives, pinion stands and screwdowns.

No. 7 mill, 20½" and 49" x 54"; 4-high, skin pass mill, 1 stand. Work rolls, drives and screwdowns.

23½" and 49" x 66"; 4-high, continuous hot strip mill. Work rolls and screwdowns.

28" 2-high structural mill, 1 stand. Vertical rolls only.

And thousands of other Timken Bearings on miscellaneous auxiliary equipment.

TIMKEN
TRADE MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO
CABLE ADDRESS "TIMROSCO"

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION ✳

Clevelands AT WEIRTON STEEL

CLEVELAND Worm Gear Speed Reducers have a 21-year service record at Weirton Steel. The first application at this plant was in 1927 when nine units were installed for Pickling Line Pinch Roll Drives in the Strip Mill Department.

As the Weirton operations have grown there have been continuous additions to the roll of Clevelands. Today more than 300 Cleveland reducers are in use in the Weirton and Steubenville plants, operating roll drives, cold strip reels, pit cover drives, roll grinders, flying shears, belt wrappers, adjustable side guards, coal grizzlies, conveyors and cranes.

Wherever Clevelands serve, steel men know from long experience that they can depend on them for satisfactory, continuous service.

The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

The complete Cleveland line includes standardized Worm Gear Speed Reducers in a variety of types and a wide range of speeds, ratios and power capacities. Special units are designed to meet unusual conditions. Our complete 150-page catalog, giving full information on all types, with specific engineering tables, furnished upon request.

18 YEARS at Weirton Steel

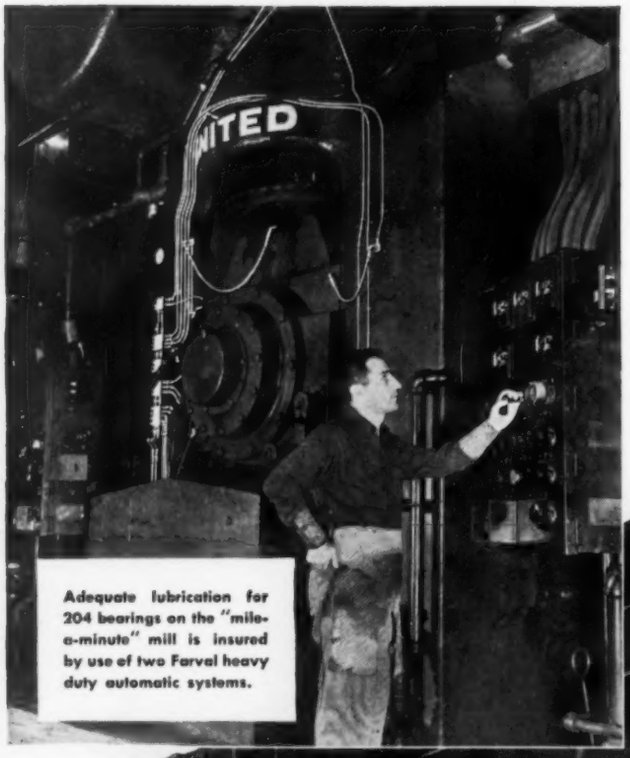
FARVAL lubricates the well-known 42-inch "mile-a-minute" strip mill at Weirton—latest of nearly 100 systems to be installed in this steel plant.

The first installation of Farval Centralized Lubrication at Weirton in 1930 was followed in 1933 with a heavy duty automatic system, installed on the 32″ Cold Strip Mill. The economies realized and the reliability of Farval led to additional installations on other major equipment—in 1939 the 35″ Blooming Mill, in 1944 the 40″ Blooming Mill, and in 1947 the new 42″ Cold Strip Mill. Other Farval systems serve uncoilers, levelers, shears, pickling and cleaning lines, tension reels, belt wrappers, etc.

Here at Weirton, as in other steel plants, Farval provides dependable, continuous lubrication—saving oiling labor and lubricant, reducing maintenance expense, and most important, contributing to uninterrupted production of steel through elimination of shutdowns and delays for bearing repair or replacement.

The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



Adequate lubrication for 204 bearings on the "mile-a-minute" mill is insured by use of two Farval heavy duty automatic systems.

Work-roll bearings of the "mile-a-minute" mill are served by one Farval system; a second system serves back-up roll thrust bearings, chuck slides, deflector rolls, spindle bearings, etc.

Prevention of Mechanical Failures in Steel Plant Equipment

. . . . many failures which plague steel plant maintenance men may be prevented by correct initial designs which reduce stress concentrations . . . . in addition, cold working the member to introduce residual stresses at critical points will eliminate many more breaks . . . .

By DR. OSCAR J. HORGER
Chief Engineer, Railway Division
and
GORDON A. STUMPF
Research Metallurgical Engineer
The Timken Roller Bearing Company
Canton, Ohio

▲ THIS paper discusses many specific cases of failures which have occurred in various machinery parts used in steel plant equipment. Both plant maintenance and operating men will be interested in the economical means employed to correct these failures which constitute an expensive item in annual operations.

Many of the failures discussed are common to the industry and accepted as something which always develops in plant operation. Yet definite improvement in life of these parts was obtained by concentrated effort in the application of modern technological practices.

Failures due to both fatigue fracture and wear are presented. In most cases no radical design changes were required but improvement in life obtained by either local changes in design, proper type of steel and heat treatment, and/or placing favorable residual compressive stresses in the surface layers by means of surface cold working the region where fatigue failure occurred.

Actual cases of failures and corrective steps taken are outlined under the following subject headings:

1. FILLETS ON SHAFTS

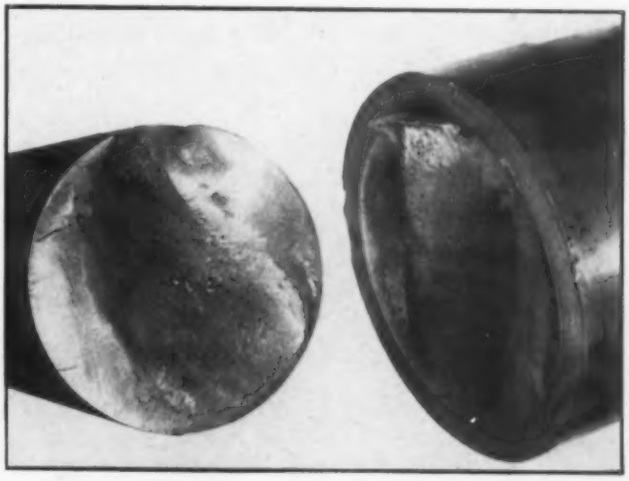
A good example of the detrimental effects of sharp fillets is reflected in the premature fatigue failure of the 6-in. drive shaft in Figure 1. This shaft was forged from SAE-4340 steel quenched and tempered to 302 Brinell. The inherent high fatigue resistance of this steel could not be realized because of the presence of such a sharp fillet.

Even if a generous fillet is provided, fatigue failures often occur. Considerable increased fatigue strength can be obtained by rolling the fillet as shown in Figure 2. For example, 5¼-in. diameter shafts of SAE-1050 steel having a $\frac{9}{32}$-in. fillet had a 30 per cent increased fatigue resistance by rolling the fillet.

Crankshafts on a large press were developing fatigue fractures in the journal fillet as in Figure 3. These failures were overcome by rolling the fillet with a single roller similar to Figure 2.

Sufficient roller pressure must be applied to plastically

Figure 1 — This fatigue failure in the 6 in. shaft was due to a sharp fillet.



Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 25, 1947

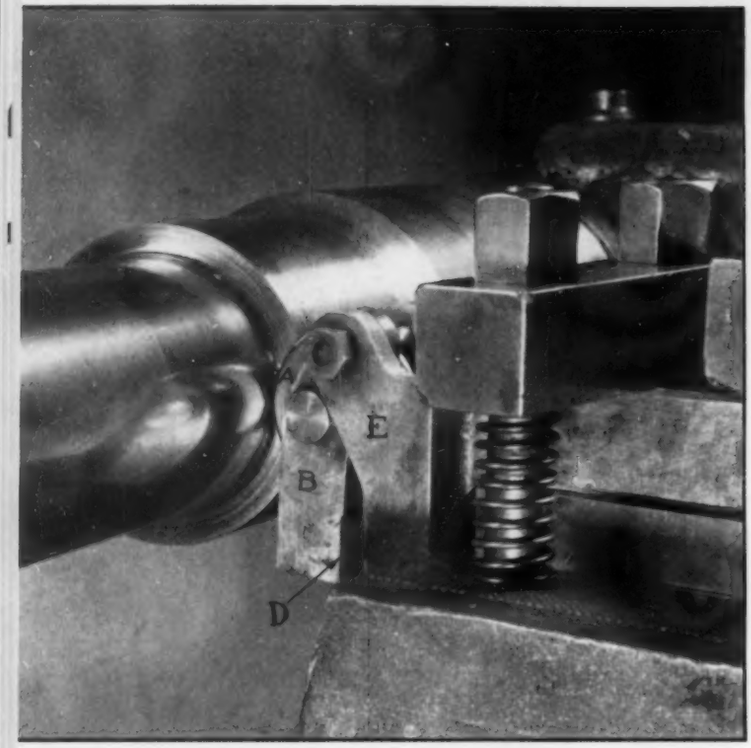


Figure 2 — In rolling the fillet, roller "A" is supported in yoke "B" which is hinged at "C" to frame "E." A calibrated rubber pad "D" is placed between "B" and "E" for flexibility and measuring roller pressure.

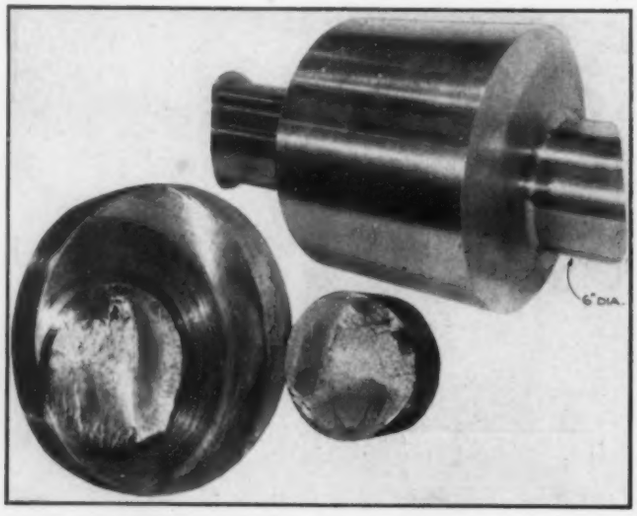
deform the surface layers of the fillet. Details of this simple and inexpensive fillet rolling operation have been previously presented[1].* Shot peening the filleted portion of shafts also leads to much increased life[2] but it is generally simpler to handle large shafts by rolling unless convenient facilities are available for adequate shot blasting.

2. PRESS OR SHRINK FITTED ASSEMBLY

A very severe stress concentration is produced in a

*Numbers refer to bibliography at end of this article.

Figure 3 — This crank shaft for 125-ton press had a fatigue failure at the fillet.



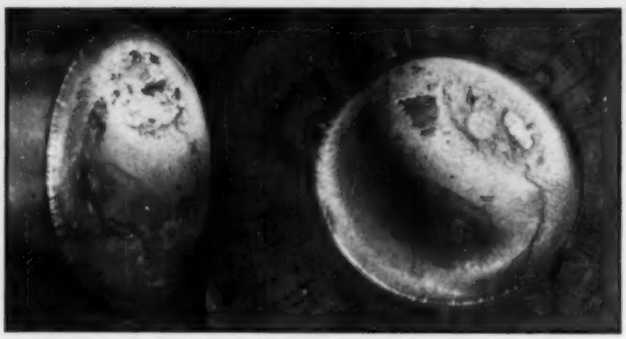


Figure 4 — Stress concentration just inside a press fitted wheel may give fatigue fractures of the shaft.

shaft when a gear, pulley or wheel is press or shrink fitted to a shaft. Typical fatigue failure is shown in Figure 4 where the shaft breaks off a short distance inside the wheel fit.

Fatigue tests made on full size 9½-in. diameter shafts of SAE-1050 steel[3], normalized and tempered, established a maximum allowable reversed bending stress in the shaft of 11,000 psi to prevent it breaking off inside the fit. By rolling the shaft in a portion of the fitted region with a three roller device as in Figure 5 this allowable stress was more than doubled to become greater than 22,000 psi. A comparison of these design values is

Figure 5 — This picture shows the method of surface rolling, in a lathe, the wheel-fit portion of a shaft.

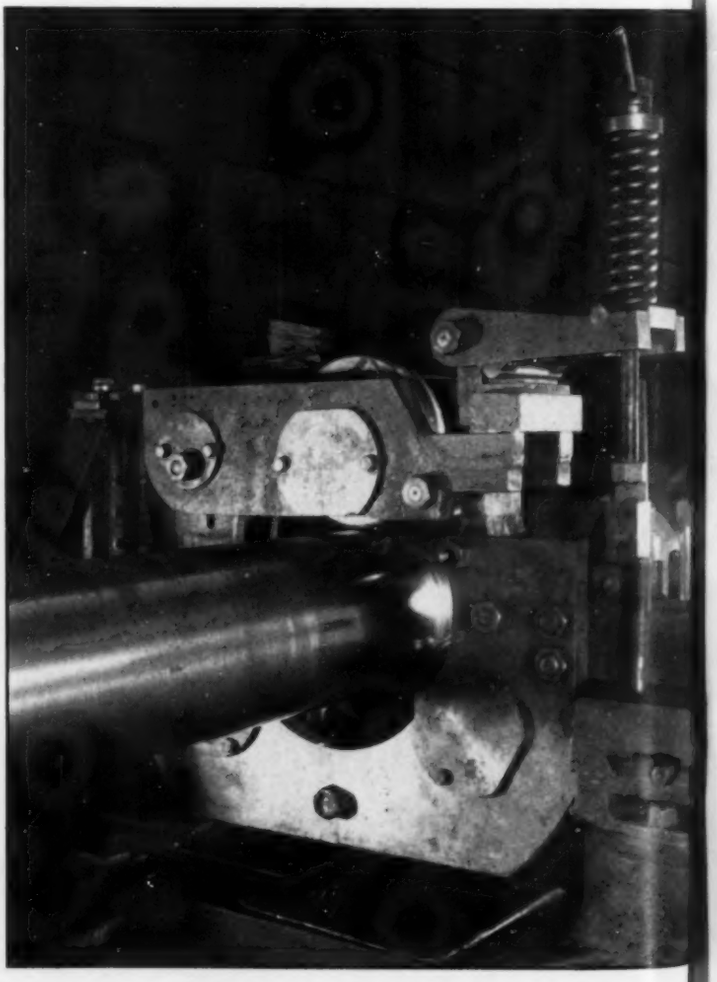
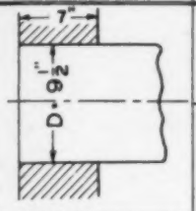
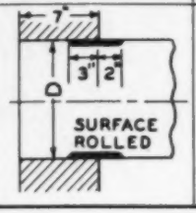


TABLE I — SUMMARY OF FATIGUE STRESSES

Design of Press Fitted Assembly	Shaft Heat Treatment	Allowable Max. Bending Stress in Fitted Portion to Prevent Shaft Breaking Off	
		P.S.I.	%
	N. & T.	11,000	100
	Water Q T-1000° F	12,500	114
	N. & T. Rolled	Greater. than 22,000	Greater than 200

shown in Table I. It will be noted that quenching and tempering the shaft gave little improvement over the normalized and tempered condition.

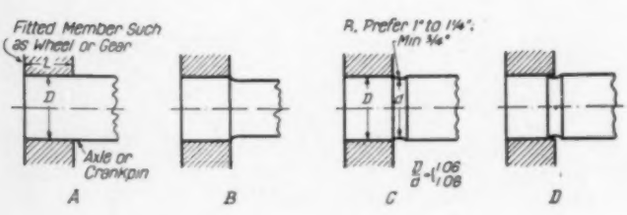
Relief grooves shown in C and D or raised seat B of figure 6 can be used to increase the fatigue resistance of the shaft over that in A. If the groove is not rolled after machining, then the shaft will fail through the groove but under a load about 20 per cent greater than if a groove was not used. If groove is rolled, then failure develops in the fitted region at a load about 40 per cent higher than if groove was not used as at A. Rolling the fitted region, of course, as in Table I in combination with either designs B, C or D having rolled fillets will give an assembly of maximum fatigue resistance.

3. RODS ON FORGING HAMMERS

Hammer rods usually fail in the tapered ram fit although some fractures may occur in the body or piston fit. Body type fractures often start from some point inside the cross section and below the surface such as in Figure 7. Here failure resulted from flaking or internal ruptures after fifty hours operation in a 35,000 pound hammer. These body fractures can be overcome by eliminating the use of steel with such internal defects.

Induction hardening[4] the tapered ram fit portion of hammer rods has been reported by some shops to give substantial increase in service life. A surface hardness

Figure 6 — These sketches are used to illustrate how rolled relief grooves can be set up to improve fatigue resistance. Sketch A illustrates conventional practice which gives low fatigue resistance.



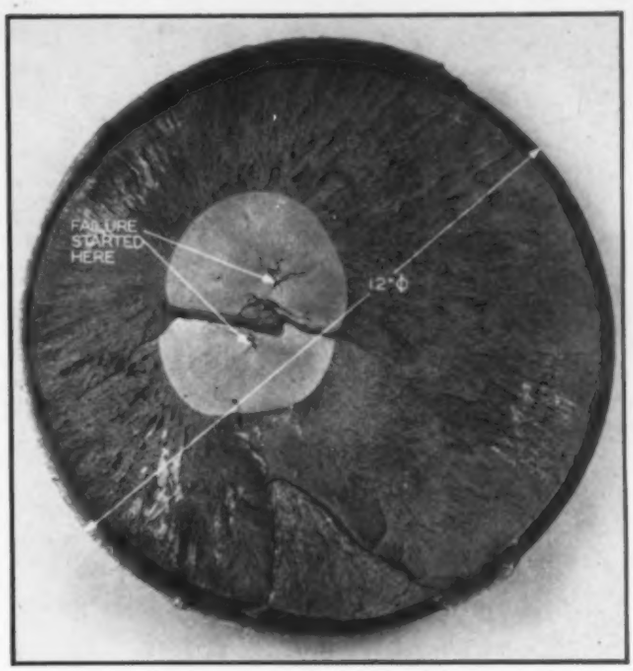


Figure 7 — In this 35,000 lb hammer rod, fatigue failure initiated from internal flakes.

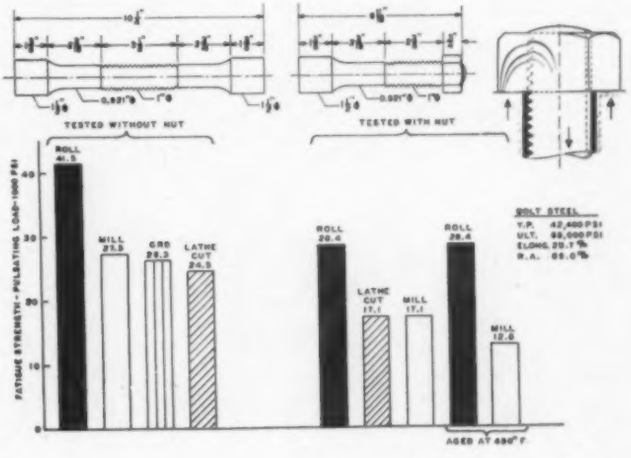
of R_c 50–55 is obtained with a core hardness of R_c 30-35. If failure develops in the piston fit then rolling the fit as in Figure 5 will contribute to longer rod life.

4. BOLTS

Threaded members often develop fatigue fracture starting within the first few threads in the nut or threaded connection. About 70 per cent increased fatigue strength has been obtained by form rolling[5] the thread instead of die or lathe cutting, grinding or milling as shown in Figure 8.

Bolts for maintenance purpose are of so many different designs that it is not always possible to purchase them with rolled threads. The threads can be cut in the usual manner and then roll the root radius only with a three roller device similar to Figure 9. The flank of the thread is not contacted by the roller. Large

Figure 8 — These graphs illustrate the fatigue strength of 1 in. bolts having threads cut, ground, milled and rolled.



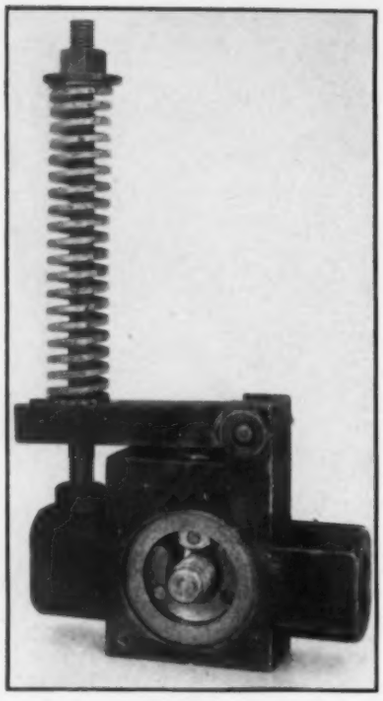


Figure 9 — This photograph shows the method of rolling the radius of screw threads on bolts.

diameter bolts such as are used in forging presses and mill stands have been rolled in a lathe with a single or multiple roller device which has a contour radius slightly less than the thread root radius. In any case sufficient roller pressure must be used to plastically deform the surface layers.

Rolled threads offers an opportunity to overcome many thread failures without design changes. Any shop can easily perform this rolling with simple equipment and in an economical manner.

5. ROLLS

Rolls used on tube reducing machines have failed in the body fillet as in Figure 10, and key fillet as in Figure 11.

Service life can be greatly extended by providing as large fillets as design conditions will permit and cold

Figure 10 — Fatigue failure at fillet on body of rotoroll machine.

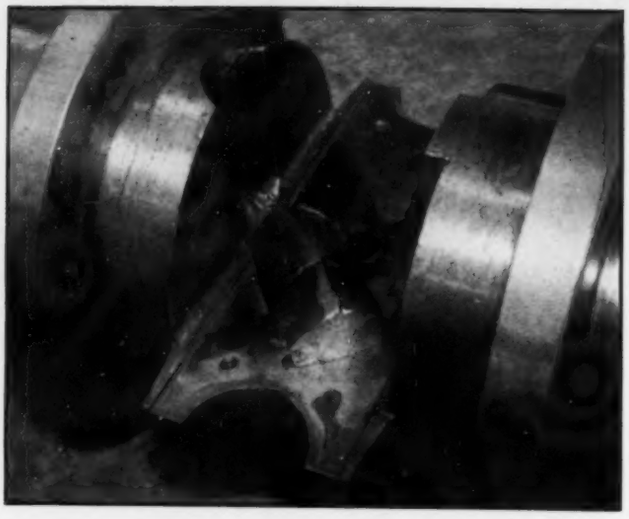


Figure 11 — In this example, fatigue failure occurred at key fillet on rotoroll.

working the fillets by rolling as in Figure 2 or using an air hammer with round nose chisel. Key fillet must be small in order to minimize wear on the sides of the key so here an air hammer can be used to advantage to cold work the fillet.

Wear conditions on the sides of key and on the die seat can be improved by locally flame hardening these areas.

While only one design of roll is discussed, these same corrective measures can be applied to other roll designs.

6. TUBE REDUCING MACHINES

Rotoroll dies shown in Figure 12 as used on tube reducing machines developed considerable difficulty with wear and fatigue failure. A number of steels and heat treatments have been placed in service operation and the best results were obtained with a 1.25 per cent carbon, 2.0 per cent chrome and 0.20 per cent vanadium analysis. This steel requires no special handling in heat treatment as it is cooled down to bath temperature in oil from 1550 F and then tempered at 400 F to give surface hardness of R_c 60-62.

These dies wear out but do not crack, spall, or develop fatigue fracture. A run of 65,000 ft of tubing is not unusual with one dressing. The high hardness is utilized to minimize wear in the key slots and on the flat seat of the die. When these dies are reground the hardness is still R_c 58 about ¼-in. below the original surface. From a standpoint of wear on the rolling surface of the die, a hardness of R_c 45-50 has been found satisfactory.

Other steels including SAE-2100 have been used but their service life was not satisfactory. Interrupted quench using both water and oil are often required with other steels and entail heat treating difficulties not present with this steel.

The reciprocating head of a tube reducing machine rolls back and forth on rollers supported by rails. A typical rail failure after 637 hours operation is shown in Figure 13. Both case carburized and through hardened steels including SAE-2100 were found unsatisfactory. Fatigue failures were eliminated and wear improved by

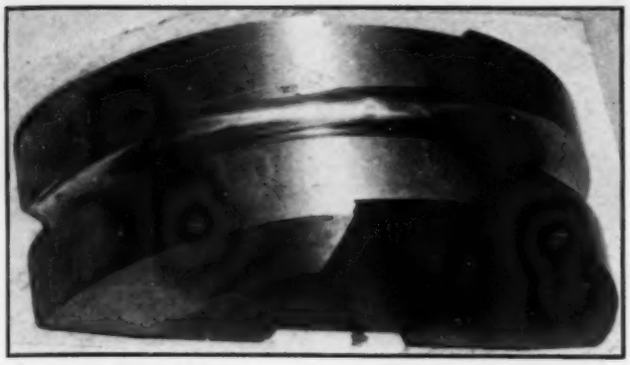


Figure 12 — A typical die used on a rotoroll tube reducing machine.

using a steel of 1.50 per cent carbon, 0.80 per cent silicon, and 0.30 per cent molybdenum. This steel is easily heat treated by quenching in oil from 1525 F and tempered to 300 F to a surface hardness R_c 60-63.

Mandrels in Figure 14 used on these machines are made from a through hardening steel of 1.50 per cent carbon chrome nickel molybdenum steel. These mandrels are oil quenched from 1500 F and tempered at 600 F for four hours to give R_c 55-57.

Other steels have been used but found to give less service life. The high rolling pressures exerted on the tube tends to roll down the mandrel causing deformation and distortion. This steel overcomes such difficulties

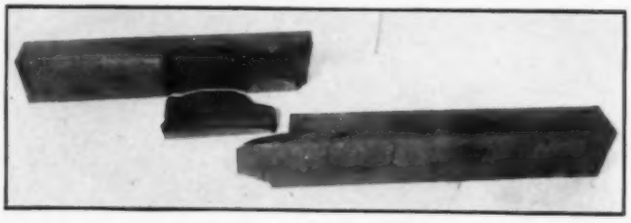


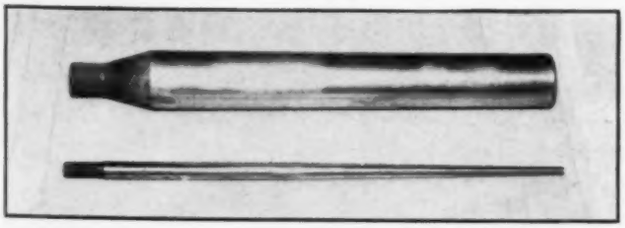
Figure 13 — Shown here is a rail failure on a tube reducing machine.

and has the same center hardness as at the surface; the wear is also minimized. Work hardening produced in these mandrels during service operation leads to surface tensile stresses of sufficient magnitude to cause failure. For this reason the mandrels are drawn at 400 F after running about 65,000 ft of tubing.

7. BILLET CHIPPING MACHINES

These machines were originally built with cast iron

Figure 14 — Mandrels of through hardened steel are used on tube reducing machines.



ways in the bed and undesirable wear soon developed. These ways were remachined and hardened liners applied as in Figure 15 which last several years longer than the cast ways. Liners are designed to facilitate replacement by making them about 2 ft in length from 1.50 per cent carbon, 0.80 per cent silicon, and 0.30 per cent molybdenum steel and attaching them to the ways by large flat head screws. Lead is then poured over the screw heads to prevent the wedging of chips.

The long traversing screw in Figure 15 was made from SAE-4340 quenched and tempered to 302-350 Brinell to develop a good combination of strength and wear properties. Screws made of other steels developed fatigue failure and undue wear.

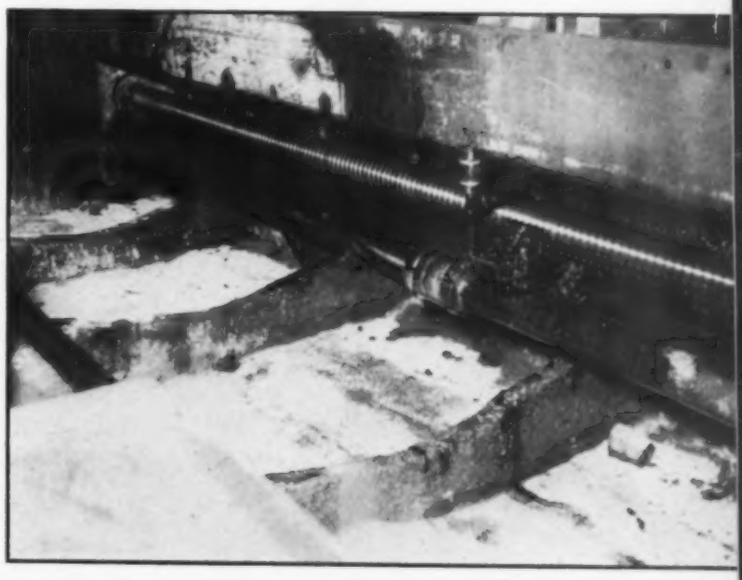
Cutting head holding the tools and the main shaft on which it is mounted in Figure 16 is made from SAE-4340 quenched and tempered to 388-425 Brinell. Since shafts of other steels twisted in service a steel giving high yield strength and deep hardenability characteristics was selected. The cutting head is heat treated before machining. Such steels as SAE-6150 was originally used and machining was done before heat treatment but quenching cracks developed or else fatigue failures occurred in service.

Wedges and backing plates to secure the tools in position are made from SAE-4620 steel case carburized to a depth of 0.070 in. Other steels including SAE-4340 developed wear early in life.

High speed steels of 0.60-0.65 per cent carbon content are used for the cutting tools. Much difficulty was experienced with chipping and fatigue failure of these tools before three temper treatments were applied. These tools are oil quenched and tempered at 1100 F; tools are then ground and the second and third temper follow at 1050 F to give a hardness of R_c 58-61.

These chipping machines must be equipped with adequate cut-out and overload switches to prevent damage to the working parts from improper operation.

Figure 15 — The guide ways on the bed of a billet chipper were lined for wear resistance.



8. COUPLING BOXES

Roll drives on mill stands are equipped with coupling boxes, Figure 17, which are designed to break so as to protect drive shafts, pinions, and rolls when excessive loads are applied. Original coupling boxes were 18½ in. diameter but their breaking strength was too great and offered little protection. The box shown was reduced to 16½ in. diameter and gives the desired safety link in the drive system with a weight reduction of 100 lb.

In some cases these boxes are cast from 0.30-0.35 per cent carbon steel if the desired safety is obtained. Alloy steel castings are used where adequate safety limits are not exceeded because it is desired to obtain wear resistance on the internal keys or lugs. When alloy castings cannot be used the keys are given a hard facing.

Length of the internal keys in Figure 17 are interrupted by a cast undercut. If this undercut is not provided then a crowding or binding action results in failure of the box when wear develops on the keys.

Figure 17 — This light weight coupling box has an undercut case between the keys.

9. INGOT MOLD CRACKING

Thermal stresses produced in ingot molds during the casting of ingots is often responsible for mold failure typical of that shown in Figure 18. Failures often develop near the open end where the axial stresses are reduced and the tensile hoop stresses increased about 25 per cent over that at other sections away from the end[6,7]. For this reason molds are often reinforced around the open end by a rib. Data on such failures have been published in two reports[8].

Cracking of ingot molds, caused by thermal stresses set up during the casting of ingots, was studied by Land[9]. Theory is developed to consider assumed plastic deformation and physical properties of ingot-mold iron influenced by temperature and stress. Under these assumptions the thermal stresses are shown to be about one half the ultimate strength of the iron. Mold shape and end effects are discussed. Residual stresses are formed as the mold cools slowly after each ingot is cast; any such residual stresses would be superimposed on the thermal stresses produced during pouring and may have a dangerous cumulative effect.

Figure 16 — Cutting head on a billet chipper.

Figure 18 — This ingot mold cracked at the open end because of thermal stresses.

10. CHARGING MACHINE AND STRIPPER CRANE

The end of the charging machine ram in Figure 19 is a steel casting about five feet long welded in position. It has a percentage composition of 0.30 C, 1.10 Mn, 0.40 Si, 1.50 Ni, and 0.12 V. This is heat treated to 90,000 psi tensile strength, 60,000 psi yield point, 25 per cent elongation, and 50 per cent reduction of area. Longitudinal cast flutes shown are important in order to prevent cracking experienced with more or less round section forged members of various steels. Heat conditions to which these rams are subjected previously caused thermal cracking when the ram was made from a forging.

The cast rectangular connection on the end of the bar which engages with the charging box should have wear resistance characteristics. This cast steel can be flame hardened at this connection to increase wear resistance.

Service life of these cast rams was increased seven times over SAE-4340 and Krupp type steel forged rams. This same type cast steel is used for the ejection arms on stripper cranes and has eliminated heat checking difficulties experienced with other steels.

11. CHIPPING CHISELS AND AIR HAMMER PARTS

Frequent fatigue failures and wear developed with chipping chisels and air hammer parts before changes in design, steel and heat treatment were made. Parts discussed are shown in Figure 20. Here the end of the chisel fitting into the hammer is given a 2 in. radius instead of making it flat. This minor change alone reduces the vibratory stresses in the chisel which lead to failure and what is most important it reduces the fatigue of the hammer operator.

Chisels are made from steel of SAE-9260 plus molybdenum analysis. They are given the simple heat treatment of oil quenching all over from 1650 F, and then tempering at 550 F to give R_c 59-62. These chisels retain good cutting characteristics and do not break in service. When they are worn too short for further re-

Figure 19 — Shown here is peel bar on the ram of a charging machine.

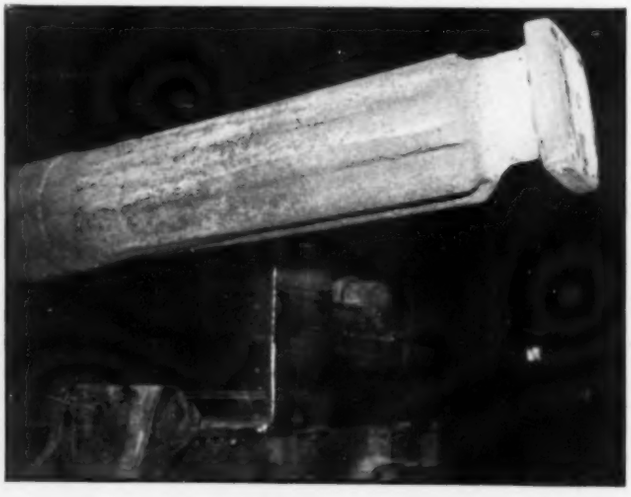


Figure 20 — The chipping chisels, air hammer piston, and bushing had frequent fatigue failures before design changes were made.

dressing, they are forged into hand chisels for other operations of cutting and grooving. For this work they are quenched in oil from 1650 F and tempered to R_c 50.

Piston in the hammer, Figure 20, is made from a 1.50 per cent carbon, 3.00 per cent tungsten, and 0.50 per cent molybdenum steel brine quenched from 1475 F and tempered to R_c 62-64. Life of these pistons is 16 months compared to one month obtained with SAE-52100 and 1.0 per cent carbon water hardening steels. Hammer bushings, Figure 20, are made of same steel and heat treatment as the pistons to give increased wear resistance.

12. GEARS

Heavy duty gears throughout the mill up to about 20 in. diameter are case carburized from SAE-4620 or 3316 steels. This practice has eliminated the continuous gear replacements required due to wear and fatigue failures, experienced with other steels of the quench and temper type. The case depth is made from 0.020 to 0.125 in. depending on the pitch which varies between 1 and 8 pitch.

One critical gear application in Figure 21 for the rotoroll drive on tube reducing machines was improved to correct tooth wear, breakage, and spalling on the pitch line. Here a SAE-4620 steel was carburized at 1700 F to obtain a 0.06 to 0.080 in. case depth; quenched in oil from the carburize; then tempered at 300 F to give minimum surface hardness of R_c 60.

Worm gear drives on the screwdown, and tilting and lift tables on blooming mills and in various other applications present wear problems with the gears. Here carburized worm gears are operated against cast nickel bronze worm wheels. The life of both gears with this combination has been found to be ten times that obtained when a soft steel worm gear is used.

13. WEAR PLATES

Worn parts lead to expensive maintenance operations so the practice has been adopted of providing easily

replaced wear plates on surfaces of machine parts subjected to wear. An example of the application of such plates is shown in Figure 22 for the saddle of a rotoroll tube reducing machine.

These plates are 1.50 per cent carbon, 0.80 per cent silicon and 0.30 per cent molybdenum steel oil quenched from 1475 F, tempered to R_c 55-62 depending upon application.

Blooming mill shears also have the above steel plates applied to the frame and bronze plates on the crosshead guide. This combination gave five times the service life of bronze liners on both parts.

14. STRAIGHTENING AND SCALE BREAK MACHINES

Small rolls or insert ring shapes for large rolls on machines for straightening and breaking scale are made from 1.50 per cent carbon, 0.80 per cent silicon, and 0.30 per cent molybdenum steel for wear resistance. This steel requires simple heat treatment of oil quenching from 1525 F and double tempered to R_c 60-63.

Large rolls are made from a carburizing type steel or an air hardening 1.5 per cent carbon, 12.0 per cent chrome steel.

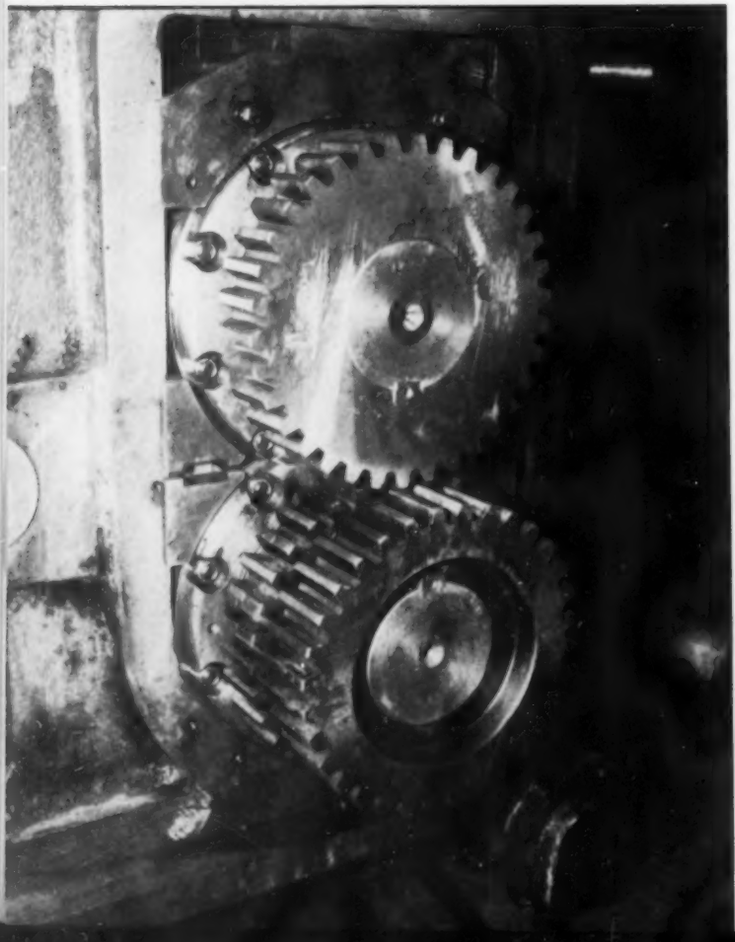
15. HOT POINTING MACHINE

Dies on a hot pointing machine are subjected to repetitive heating and water quenching. Some steels used for these dies develop cracks, soften, and upset in operation. A 1.5 per cent carbon, 0.80 per cent silicon, 0.30 per cent molybdenum steel oil quenched from 1525 F and drawn at 700 F to R_c 47-50 has overcome these difficulties.

Pistons operating the dies usually operate in bronze lined cylinders. These bronze liners have been replaced by steel to give several times the life of the non-ferrous material. Steel used is same as for the dies mentioned above except it is tempered to 250-285 Brinell.

Figure 22 — For parts which wear, wear plates often provide the solution as illustrated by those shown on a roll housing.

Figure 21 — Case carburizing the gear drive on this tube reducing machine increased gear life.



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DISCUSSION

PRESENTED BY

R. L. RECTENWALD, Chief Engineer, Metalock Repair Service, Pittsburgh, Pennsylvania

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DR. O. J. HORGER, Chief Engineer, Railway Division, The Timken Roller Bearing Company, Canton, Ohio

L. E. FULLER, JR., Superintendent, Maintenance Planning Department, Carnegie-Illinois Steel Corporation, Chicago, Illinois

KARL ARNOLD, Lubrication Engineer, National Tube Company, Ellwood City, Pennsylvania

BRUCE JOHNSTON, Director, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pennsylvania

R. L. Rectenwald: I did not understand where the 1⅝-in. radius on the chipping tools is machined. Is it on the end of the tool which fits into the hammer?

Gordon A. Stumpf: It is on the end of the tool that fits into the hammer. The reason for that is, we want the center line of the piston blow to hit the center line of the chisel. If it hits off center, it vibrates the chisel, fatigues the man, and breaks the chisel.

R. L. Rectenwald: Is it necessary, then, to have the same radius on the hammer?

Gordon A. Stumpf: No, that is not necessary. Make the end of the piston perpendicular to the axis of the hammer. As a result, when you change either the piston or the chisel, it will fit into the radius that is already forming in the end of the piston.

R. L. Rectenwald: I should also like to ask what unit pressure is used on the rollers with which you roll the fillets in the crankshaft.

Dr. O. J. Horger: The contact rolling pressures are high enough to cause plastic deformation of the surface layer. The actual stresses are above the yield point strength so that calculated values are not valid but would run around 5000 to 7000 psi. As an example, a diameter shaft having a ground surface will be reduced about 0.001 in. diameter with a rolling pressure of 25,000 lb using 10 in. diameter rollers with a contour radius of 1½ in. If the shaft has a smooth turned surface, the decrease due to rolling will be greater depending upon surface roughness. Such rolling pressure will give a hardness penetration of about ¾ inch.

This cold working should not be confused with ordinary cold drawing operations where a large per cent reduction occurs. Rolling referred to here gives a small fraction of 1 per cent reduction on diameter, and you get compressive stresses on the surface whereas in cold drawing you get tension.

R. L. Rectenwald: Do you have any data giving the increase in surface hardness?

Dr. O. J. Horger: Yes, you get about 50 points Vickers increase in hardness. The usual Rockwell or Brinell type of hardness measurements are not sensitive enough.

L. E. Fuller, Jr. I am very much interested in the design of the fluted charging machine ram illustrated during your talk. We are presently using a forged, round body ram end and are having considerable difficulty with thermal cracks back of the head. Do you have any figures on the life of the fluted cast steel ram end compared to a forged, round body, steel ram end?

Gordon A. Stumpf: The life is about five to seven times longer and we have increased the size of the throat from the body to the square head, and it will be more than that in the future. When forgings were used, we tried low carbon, high carbon, and the heat resisting steels, but none of them approached the life of these castings.

L. E. Fuller, Jr.: We are constantly replacing the forged end which is thermit welded to the ram.

Gordon A. Stumpf: The fluting apparently does away with the cracking. A ram that has been used about four months shows no cracks.

L. E. Fuller, Jr.: Did you increase the over-all diameter of the ram end when the fluted design was installed?

Gordon A. Stumpf: No.

L. E. Fuller, Jr.: It is still the same size?

Gordon A. Stumpf: That is right.

Karl Arnold: On your tube reducing mandrels, do you have any success with chrome plating, or superfinishing of any type, to increase the life of the mandrel?

Gordon A. Stumpf: We have chrome plated some mandrels, but that is an inferior practice. They last only a few hours and the plate starts to peel off. The material we use, after the first tube is run becomes highly polished and then it runs on for thousands of feet and remains highly polished.

Professor Bruce Johnston: Can you say there is one basic factor which accounts for increase of fatigue resistance due to rolling the surface? If so, what is it?

Dr. O. J. Horger: Favorable residual compressive stress produced in the surface by rolling is one of several contributing factors responsible for such increased fatigue resistance. These initial compressive stresses help offset the tensile stresses produced in service operation. An analogy from the medical field may be cited where resistance to typhoid fever is obtained by inoculation; here we are inoculating the steel with initial stresses to increase internal resistance to externally applied stresses. This is a simple physical explanation and the actual one is more complicated.

We can get these initial stresses in the surface by some form of cold working operation, shot peening, and also by heat treatment. In order to get these residual stresses by quenching and tempering, the usual drawing temperatures employed are too high. For example, a shaft in the as-quenched condition has residual compressive stresses in the surface layer. Drawing the shaft at 1000 F removes most of these initial stresses. Tempering at 750 F has been found to give greatly increased fatigue strength of 9½ in. diameter press fitted assemblies over the 1000 F draw. An effect is obtained similar to that obtained by rolling the surface, but metallurgists usually disagree with using such drawing temperatures as 750 because of lower impact values and the danger of temper embrittlement. However, a number of such shafts tempered at 750 F have been placed in very highly stressed applications with good success to date.

TRENDS IN DESIGN AND APPLICATION of Lifting Magnets

. . . . a new electric magnet in a welded design gives a sealed unit which prevents the entrance of moisture, and allows the design of a flatter coil which aids in heat dissipation . . . .

By JOHN D. LEITCH
Chief Engineer
Electric Controller and Manufacturing Company
Cleveland, Ohio

▲ LIFTING magnets have been in common use in the steel industry for many years and have become an indispensable part of the materials handling equipment in this and allied industries. Recent improvements in design and construction have increased their efficiency and their ability to withstand the severe mechanical and electrical abuse to which they are subject. Consequently, a discussion of the trends in lifting magnet design and application is of interest to many steel mill men.

In general, there are two basic designs of lifting magnets. The circular or rectangular magnet in which the magnetic circuit embraces the coil is the most common of these two designs. The circular magnet is merely a modification of the rectangular magnet in that the two outer poles are reduced to one continuous outer pole. The other basic design, often referred to as the bi-polar magnet, is one in which the coil or coils embrace the magnetic circuit. Such a magnet may have one or more coils depending upon its shape and intended use. These two basic designs are characterized by the following. The coil of the bi-polar magnet has a relatively short mean turn, giving greater ampere-turns per pound of copper, but the complete magnet has a longer average flux path and greater magnetic leakage. Circular and rectangular magnets, on the other hand, have a relatively long mean turn and low ampere-turns per pound of copper. However, their flux path is shorter and magnetic leakage lower.

GENERAL DESIGN CONSIDERATIONS

In designing a lifting magnet, its principal dimensions are either chosen arbitrarily or are determined by the nature and the size of the load to be lifted. Having selected any outline dimension, such as the diameter of a circular magnet, the most important factor in determining the area of the iron cross-section is the permeance of the load. Loads of higher permeance require a greater iron section and less ampere-turns. In other words, a heavy slab of steel providing good contact with the magnet pole faces can be lifted by a magnet having relatively few ampere-turns and large iron section, while a low permeance load such as steel turnings can be handled more effectively by a magnet having a smaller iron section and more ampere-turns.

It is well known that the relationship between the magneto-motive force, total flux and the reluctance of the flux path of a magnetic circuit is given by

$$\frac{\text{MMF}}{\text{Reluctance}} = \text{Total Flux}$$

The permeance of the magnetic circuit is the reciprocal of its reluctance, hence

$$\frac{\text{Total Flux}}{\text{MMF}} = \text{Permeance}$$

If the magneto-motive force is expressed in ampere-turns, the permeance of a magnetic circuit may be defined as the flux per ampere-turn

$$\text{Permeance} = \frac{\text{Total Flux}}{\text{Ampere-turns}}$$

In designing a general purpose circular magnet of a given diameter, it is necessary to select an average load permeance. This is usually that of pig iron or average grade of open hearth scrap. The permeance will, of course, depend on the size of the magnet, being approximately proportional to the diameter for circular magnets.

Another consideration of importance in the design of

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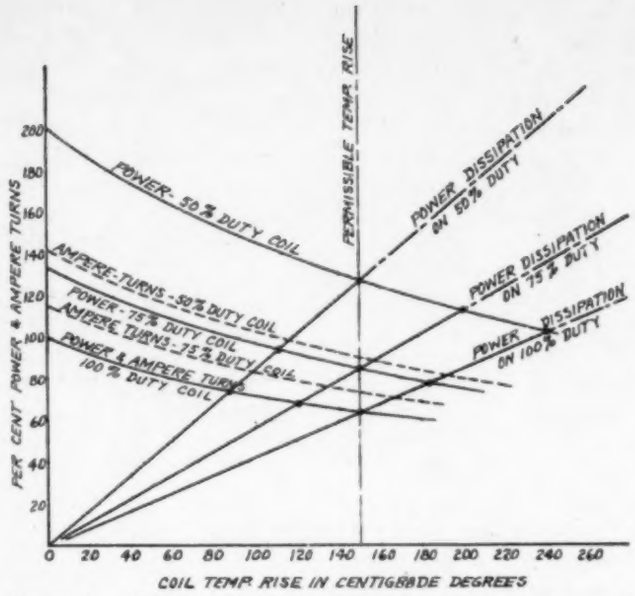

PERMISSIBLE TEMP. RISE
POWER - 50 % DUTY COIL
POWER DISSIPATION ON 50% DUTY
AMPERE-TURNS - 50% DUTY COIL
POWER DISSIPATION ON 75 % DUTY
POWER - 75% DUTY COIL
AMPERE-TURNS - 75% DUTY COIL
POWER DISSIPATION ON 100 % DUTY
POWER & AMPERE TURNS 100 % DUTY COIL
PER CENT POWER & AMPERE TURNS
COIL TEMP. RISE IN CENTIGRADE DEGREES

Figure 1 — These curves show the power input and ampere-turns versus temperature rise for coils designed for different duty cycles.

a lifting magnet is the duty cycle on which it is to be operated. The usual practice is to design general purpose magnet coils on the basis that they will be energized fifty per cent of the time. The permissible temperature rise must be decided upon in order to determine the maximum allowable watts input, and is usually about 150 C as measured from the increase in coil resistance.

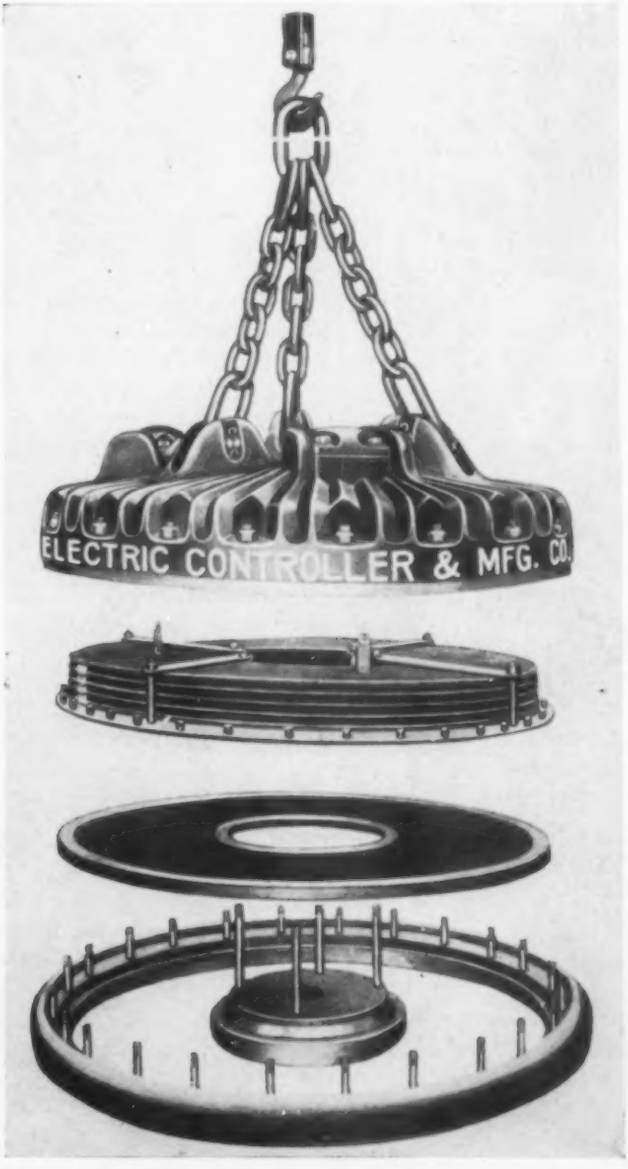
Since all of the heat is generated in the coil, it is obvious that the coil should be designed for a maximum rate of dissipation of heat. The insulation between turns, between layers, and surrounding the entire coil should be as thin as possible in keeping with adequate protection against grounding or short-circuiting. The coil itself should present as great a surface area as possible for a given number of ampere-turns. A thin flat coil not only presents a greater area for a given mass of material, but it is also a better heat conductor than a thick coil. The thickness of the coil is, of course, determined by the radial length of the coil space and by the ampere-turns required by the load permeance.

The space-factor of a coil winding may be defined as the ratio of the copper cross-section to the total cross-section of the winding, while the overall space-factor of a coil is the ratio of the copper cross-section to the cross-section of the total available coil space. The higher these space factors are, the more efficient the dissipation of heat and the higher the ampere-turns. Any features of the design which improve the space factors are desirable.

Because of the great amount of inductive energy stored in a lifting magnet, it is necessary to employ a suitable controller which limits the peak voltage at the magnet terminals during the discharge and reversal of the current in the magnet. The insulation of a magnet

Figure 2 — In the conventional circular magnet, the inner and outer pole shoes are held against the case with bolts.

Figure 3 — Shown here are the components of the conventional circular magnet.



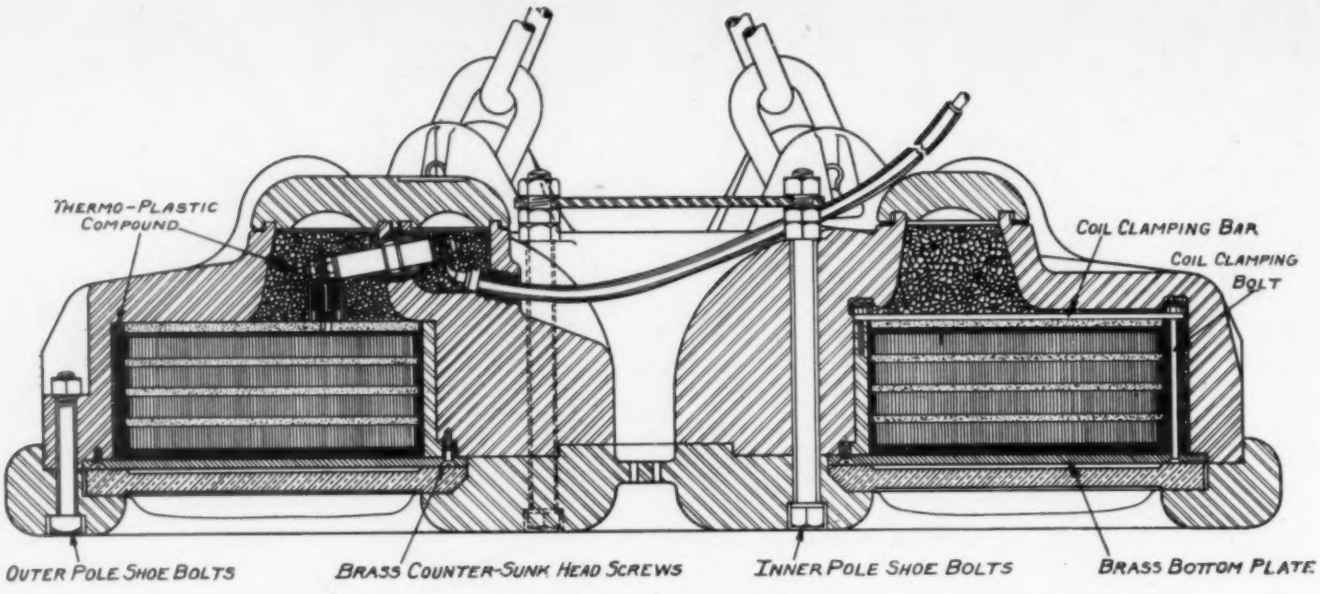


Figure 4 — Cross-section of bolted magnet.

between turns, between layers, and between the coil and the magnet case, however, must be adequate to withstand any voltage surge which may arise, even without the benefit of a controller, since at any time a cable may snarl and break.

It is important in the design of an efficient electromagnet that the flux density at all points within the magnet core or case be uniform. This requires the elimination of all "bottlenecks" in the magnetic circuit and the maintenance throughout the case of a constant iron cross-section perpendicular to the flux path. This condition defines the outer wall thickness in terms of the inner pole diameter, provided of course, the thickness so determined gives sufficient mechanical strength.

When handling scrap iron or pig iron with a lifting magnet, the flux density is high only at the points of contact of the pole faces and the material. Consequently, in order to take full advantage of the total cross-sectional area of the iron in the magnet case, the pole shoes should present a greater area to the load. To a first approximation, the area of the pole shoe faces should be about twice the area of the magnet case cross-section which allows for about 50 per cent contact between the pole shoes and the load. If, however, the magnet is not a general purpose magnet, but one designed for lifting heavy slabs with intimate contact over the entire area of the shoe faces, the area of the shoes should be equal to or slightly less than the magnet cross-section for maximum lift.

EFFECT OF TEMPERATURE RISE ON WATTS INPUT AND AMPERE-TURNS

The resistivity of copper increases approximately 0.4 per cent per centigrade degree rise in temperature above 25 C. Thus, at a temperature rise of 150 C, the increase in resistance of a magnet coil is 60 per cent. With constant voltage applied to a magnet, both the watts input and the ampere-turns are reduced to 63 per cent of their 25 C values. It is therefore important, from the point of view of maintaining a high lifting capacity, that a magnet be operated on as low a duty cycle as possible.

EFFECT OF TEMPERATURE RISE ON RATE OF DISSIPATION OF HEAT

The temperature rise at the surface of a lifting magnet is considerably less than that of the coil, and consequently radiation plays a less important part than conduction and convection in cooling the coil. It can be shown experimentally that the rate of dissipation of heat from the coil of a lifting magnet is approximately

Figure 5 — The general purpose circular magnet is now available in a welded design.

proportional to the temperature rise as measured by the increase in resistance of the winding. If the working temperature of the coil were higher than that usually encountered, the rate of heat dissipation would depart somewhat from this linear relationship, tending to increase more rapidly with rise in temperature in accordance with Stefan's radiation law.

EFFECT OF DUTY CYCLE ON THE RATINGS OF A MAGNET COIL

By application of the usual rules, it is easy to estimate the intermittent ratings of a lifting magnet coil in terms of its continuous rating. For the same coil and temperature rise, the 50 per cent duty cycle current rating is $\sqrt{2}$ times its continuous rating while its 75 per cent duty cycle rating is $\sqrt{\frac{4}{3}}$ times its continuous rating. The corresponding ratings in watts are 2 and $\frac{4}{3}$ times the continuous rating respectively.

EFFECT OF DUTY CYCLE ON COIL DESIGN AND AVAILABLE AMPERE-TURNS

If we assume constant voltage and design a group of coils for any given magnet such that the temperature rise will be the same for 50, 75, and 100 per cent duty cycles, it is apparent that the resistance of the 50 and 75 per cent duty cycle coils will be respectively ½ and ¾ that of the continuous duty coil.

Assuming a constant coil space and a constant space-factor for the three windings, the resistance of the coil increases as the thickness of the copper strap is reduced. If N is the number of turns and t is the thickness, then for constant space-factor

$$Nt = \text{a constant}$$

The coil resistance R increases as the number of turns is increased and as the thickness is decreased so that

$$R \propto \frac{N}{t} \propto N^2$$

For constant voltage, the current I is inversely proportional to the resistance

$$I \propto \frac{1}{R} \propto \frac{1}{N^2}$$

thus

$$NI \propto \frac{1}{N}$$

These generalizations are tabulated in Table I. The ampere-turns vary inversely as the number of turns while the current and watts vary inversely as the square of the turns. These results are based on a constant space-factor for the three windings. Actually, as the thickness of the strap is reduced and the number of turns increased, the space-factor becomes smaller and the resulting ampere-turns are slightly less than that shown by the table.

TABLE I

Duty cycle, per cent	Watts	Resistance	Current	Turns	Ampere-turns
100	W	R	I	N	NI
75	4/3 W	3/4 R	4/3 I	$\sqrt{3/4}$ N	$\sqrt{4/3}$ NI
50	2 W	1/2 R	2 I	$\sqrt{1/2}$ N	$\sqrt{2}$ NI

The effect of temperature rise on watts input and

Figure 6 — Sub-assemblies for all-welded magnet.

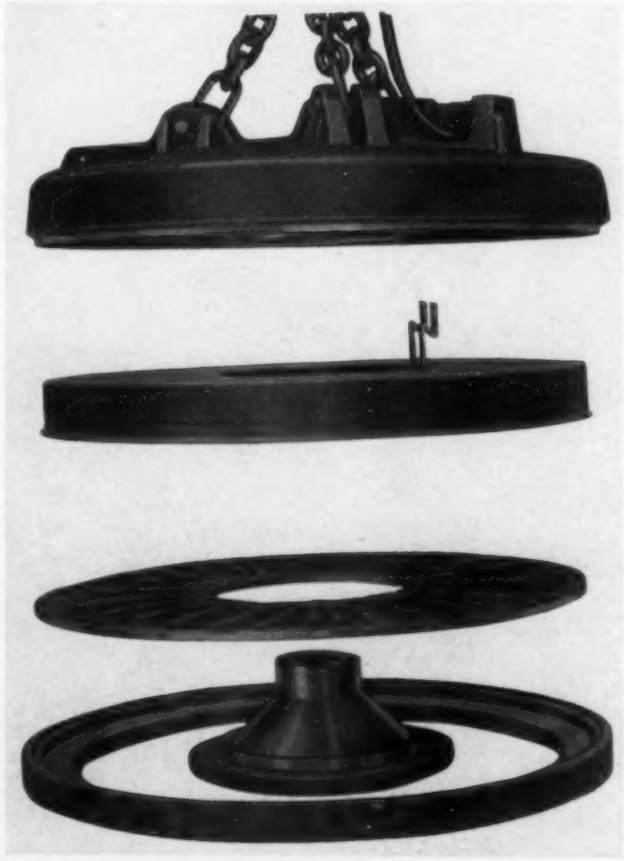
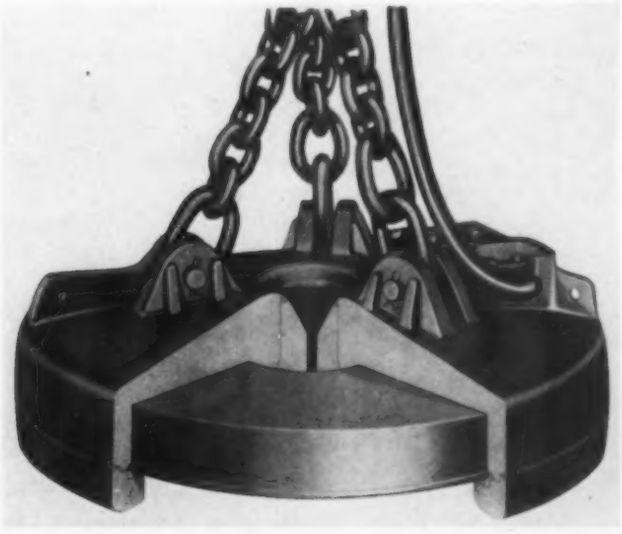


Figure 7 — The method of welding the pole shoes to the case is shown in this photograph.



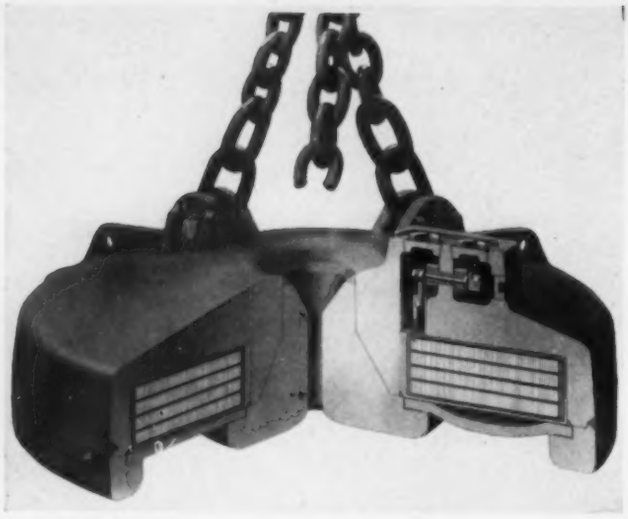


Figure 8 — This cutaway view shows how the leads are brought out of the case of the welded magnet.

ampere-turns is shown graphically in Figure 1 for the three coils listed in Table I. These curves also show the effect of operating a magnet on a duty cycle different from that for which its coil was designed. For the sake of comparison, the watts and ampere-turns are arbitrarily chosen at 100 per cent for the continuous duty coil. It will be observed that the power requirements increase much more rapidly than the available ampere-turns for coils designed for intermittent service. Since the three coils were designed for the same temperature rise when operated on their respective duty cycles, the power dissipation curves must intersect the power input curves at the same temperature rise.

COIL SPACE-FACTORS

The space-factor of the winding itself is determined by the thickness of the insulation between turns and between layers. It is customary to design coils for lifting magnets with copper strap arranged in layers. Since the insulating material between turns has a minumum thickness fixed by mechanical requirements, the space-factor is reduced as the thickness of the copper strap is reduced. The overall space-factor of the coil expresses the copper cross-section as a percentage of the total available coil space. If, for mechanical reasons, it is necessary to clamp the coil to the hub on which it is wound, the clamping bars and bolts cause a decrease in the overall space-factor since they occupy space which might be used to advantage. Further, if by the use of an improved insulating compound the clearance between the outer edge of the coil and the magnet case could be reduced, additional space would be available for active winding. It will be shown later that in the design of an all-welded lifting magnet, advantage was taken of these two considerations to increase the overall space-factor.

COMPARISON OF OLD AND NEW DESIGNS

In comparing the earlier designs of lifting magnets with those of more recent date, the circular type only will be considered. For convenience the old design will be referred to as the bolted magnet to distinguish it from the new all-welded magnet. Figure 2 shows a conventional circular magnet with both the inner and outer pole shoes held against the case with bolts. It will be noted that the covers of the terminal boxes are fastened with cap-screws.

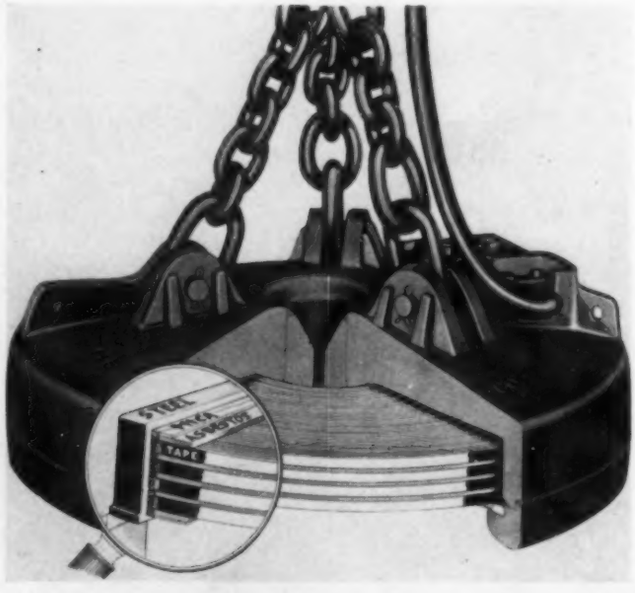
The various parts of the bolted magnet are shown separately in Figure 3. The coil is of particular interest. It is wound on a steel hub which fits over the central core of the case. A flat brass plate is fastened to the hub with countersunk screws. The winding is held rigidly to the brass plate and steel hub by clamping bars and bolts. The coil assembly in turn is fastened to the case with screws as shown in Figure 4. The non-magnetic manganese steel bottom-plate is held in place by the inner and outer pole shoes and protects the coil from direct impact during service.

The disadvantages of the bolted construction are:

1. The effective area of the magnet is reduced by the space required for the outer pole shoe bolts.
2. Bolts tend to stretch with repeated stressing introducing air-gaps between the pole shoes and the body of the magnet.
3. The space required for the bolts and bars used in clamping the coil winding to the steel hub and brass bottom-plate reduces the overall space-factor.
4. The use of gaskets and screws on the covers of the terminal boxes and at the joints between the coil and the case does not adequately prevent moisture from entering the winding.
5. Expansion and contraction of the thermo-plastic insulating compound gives rise to "breathing" with possible accumulation of moisture within the terminal boxes and the coil.

The new all-welded magnet is shown in Figure 5. The absence of all bolts and screws gives the magnet a streamlined appearance. Figure 6 shows the same group of components for the all-welded magnet as Figure 3 does for the bolted magnet. One of the outstanding differences in the two designs is apparent by comparing the two coil assemblies. The coil of the all-welded

Figure 9 — This view shows details of insulating the coil



magnet is a steel-enclosed hermetically sealed unit which can be carried as a spare part. The coil is wound in layers on a steel hub as in the old design, but instead of a brass bottom-plate fastened with screws, a steel plate is now welded to the hub.

After the coil has been wound, it is enclosed in a prefabricated metal cover or shell made of mild steel. The cover is welded to the hub and to the bottom-plate of the coil while held under pressure. The cover therefore acts as a clamping means to prevent the coil from rotating about the hub. The leads are brought out of the coil cover through a heavy block of insulation and sealed with glyptol.

The outer and inner pole shoes are shown at the bottom of Figure 6. The inner pole shoe is of particular interest in that it has a conical surface accurately machined for intimate contact with a corresponding surface on the magnet case.

Figure 7 shows how the inner and outer pole shoes and the outer edge of the coil bottom-plate are welded to the magnet case, and Figure 8 shows how the coil hub is welded in place. Figure 8 also shows how the leads are brought out to the terminals in the inner terminal box. The insulator between the inner and outer terminal boxes is shown together with the pipe-plugs used in sealing the boxes against moisture. Auxiliary pipe-plugs seal the holes used in machining the barrier between the two terminal boxes.

Figure 9 shows a cutaway view of the assembled magnet coil and case. It will be noted how the elimination of the clamping bars and bolts permits greater use of the available coil space for active winding, and how the elimination of the outer shoe bolts provides a coil space of greater radial length. These two factors permit the design of a flatter coil which presents a greater surface area for more efficient heat dissipation. Welding the outer pole shoe is not new. This has been done for many years on magnets which were originally designed for bolted construction. When, however, a magnet is designed with the idea of welding in mind, full advantage may be taken of these savings in space.

Figure 10 — The details of bringing the magnet leads out of the terminal box are so designed as to prevent moisture from entering the magnet.

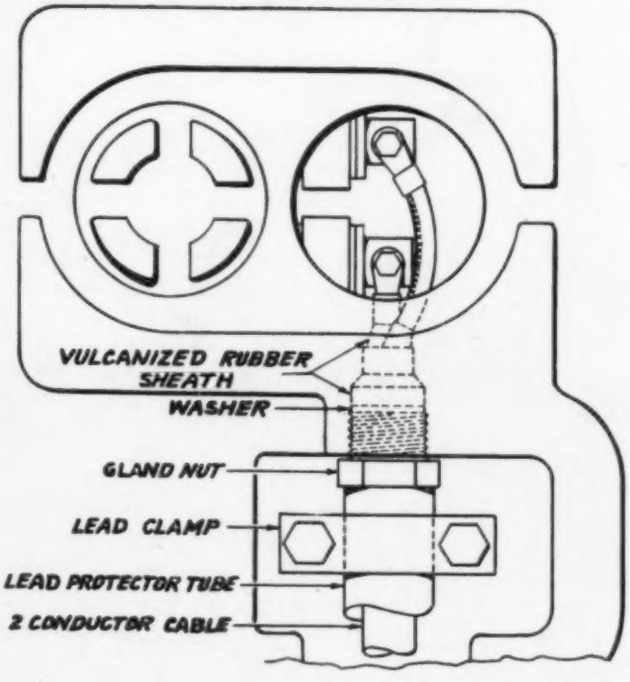


Figure 11 — In the steel mill, one of the most common magnet uses is with the skull cracker.

One of the more important changes in the coil design of the all-welded magnet is the use of a steel bottom-plate in place of a brass plate. Upon first consideration, the use of magnetic material across the coil face might be questioned on the basis that it short-circuits the magnetic circuit. It can be shown by calculation and confirmed by experiment that the effect of the steel plate in reducing the magneto-motive force across the pole shoes is negligible and that in handling low permeance loads there is no appreciable change in the lifting capacity of the magnet. For loads of high permeance a small percentage of the total flux is diverted from the pole shoes with a corresponding reduction in lifting capacity. However, a general purpose magnet is rarely called upon to lift a load of so high a permeance that this loss of flux is of any consequence.

It has been common practice for years to impregnate and surround the coil with a thermo-plastic material such as asphaltum. This demands the use of large terminal boxes which are in a sense expansion chambers. If too much impregnating compound is added to a magnet initially, excessive pressure resulting from rise in temperature causes the compound to leak at the terminal boxes, at the outgoing leads or at any joint which cannot withstand the pressure. The repeated expansion and contraction of the compound as it heats and cools is responsible for the "breathing" already mentioned.

It was realized that the use of a thermo-setting compound, one which polymerizes at a temperature in excess of the operating temperature of the magnet,

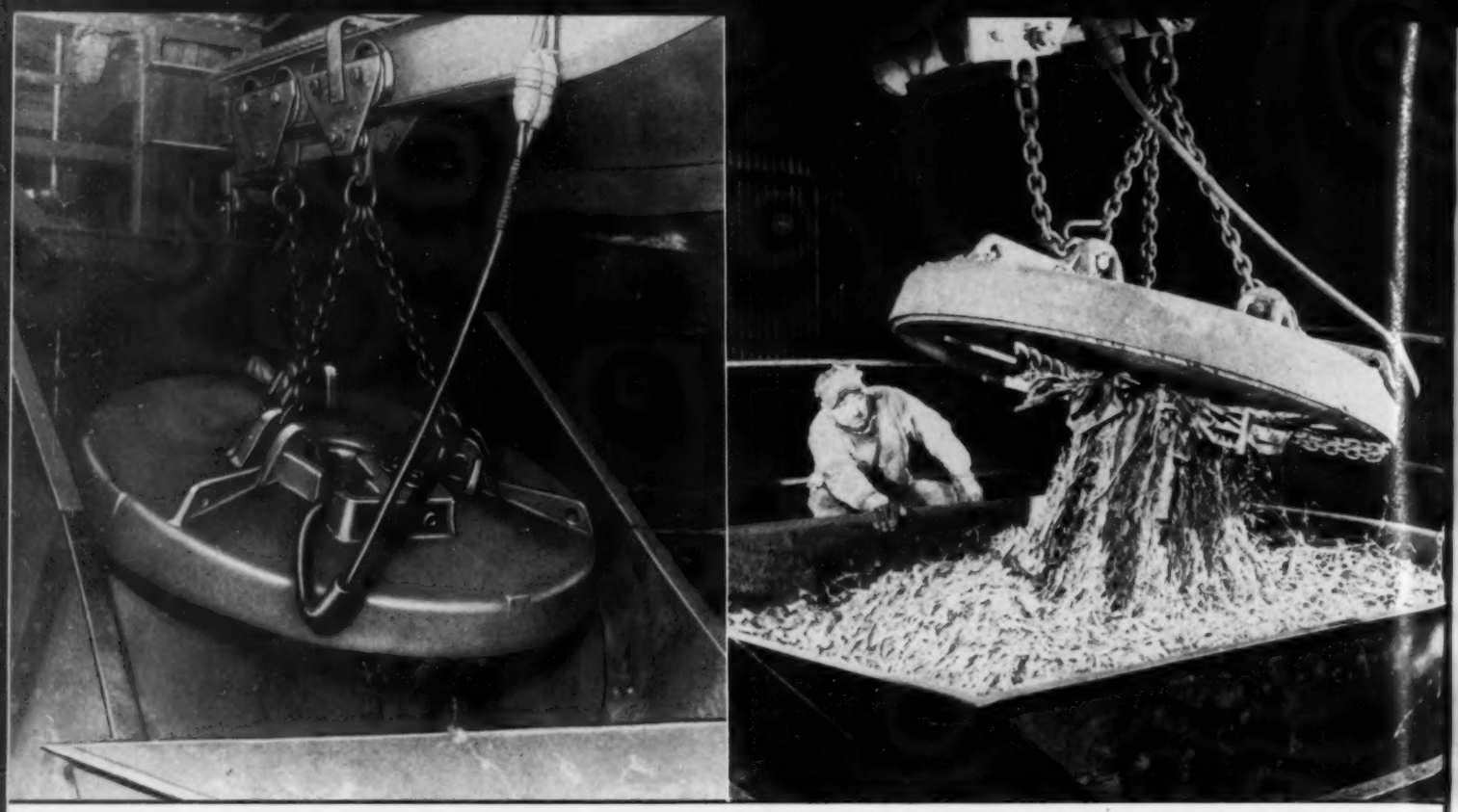


Figure 12 — This separator magnet is used over a 60 in., 600 fpm belt handling 2800 tons of bituminous coal per hour. Magnet is mechanically latched in position over head pulley, and after discharge, the magnet is returned up I-beam trolley by chain winch.

would eliminate the "breathing" and reduce the probability of moisture entering the magnet. One of the first projects associated with the design of the all-welded magnet was the development of a suitable compound for this purpose. Many resins and oils were investigated in conjunction with a variety of fillers for the purpose of obtaining a good insulating compound which would have a negligible coefficient of expansion and good adhesive properties, and which would also remain resilient over a wide range in temperature. Such a compound has been developed and has proven satisfactory in both cold and warm weather as well as in handling steel at about 1000 F. The use of this compound permitted the design of much smaller and more compact terminal boxes and allowed a reduction in the space between the outer edge of the coil and its cover thereby further improving the overall space-factor.

All of these improvements were incorporated in the design of the all-welded magnet resulting in a coil of greater surface area capable of dissipating heat at a greater rate. This permitted an increase in the ampere-turns and iron cross-section for a given temperature rise with a consequent increase in lifting capacity of from 10 to 25 per cent over magnets of the bolted design.

Because of the low flux density in the pole shoes relative to that in the magnet case, it is not necessary to use a high permeability steel for the shoes. Consequently, both the inner and outer pole shoes are made from a wear-resisting alloy giving a magnet of greater life.

It is customary to employ a two-conductor cable for leading power into a lifting magnet. By splitting the cable into its two individual conductors and vulcanizing the "split" so that the joint extends within the outer terminal box as shown in Figure 10, danger of moisture entering the magnet via the space between the insulation of the two individual conductors is overcome. By forming a shoulder on the cable behind the "split," the vulcanized rubber sheath can be used as packing in sealing the cable at the stuffing box. The only remaining path for water to enter the terminal box is through the spaces between the individual strands of the cable, a problem that can be taken care of by soldering a solid-end ferrule over the free end of the cable at the cable connector.

MAINTENANCE AND REPAIR

The most difficult and time consuming operation in repairing a lifting magnet is rewinding a coil. This requires dismantling the entire magnet, cleaning the old copper, rewinding and reassembling. With the old design a magnet would be out of service for weeks for this job alone. More than likely, the inner and outer pole shoe bolts would have to be burned off. The brass bottom-plate would have to be replaced and new insulation between turns and layers provided. With the new design, replacing a coil is merely a matter of cutting away the welds between the case and the inner and outer pole shoes along with the two welds which fasten the coil to the magnet case. A new hermetically sealed coil can be carried in stock as a spare and installed at once by welding it in place. The inner and outer pole shoes can then be welded in position and the magnet returned to service.

In replacing a set of worn shoes with new ones, less time should be required with the all-welded magnet

than with the bolted magnet provided, of course, a suitable boring mill is available.

Most of the troubles with lifting magnets occur within the terminal boxes or at the points where the leads enter the boxes. In the all-welded magnet it is necessary only to remove one pipe-plug to disconnect a cable, and if it is necessary to replace the insulator between the inner and outer terminal boxes, a second pipe-plug can be removed from the top of the inner terminal box.

Every effort should be made to keep moisture out of the terminal boxes. If a set of leads breaks in service, a new set should be installed in the same manner as the original set. A temporary splice or reconnection may be necessary, but at the first opportunity a new set of leads should be provided from spare parts. This is important in any campaign to reduce outage time of lifting magnets.

OPERATION OF A LIFTING MAGNET

It is not intended to discuss magnet controllers in this paper, but rather the operating duty cycle and its effect on temperature rise and efficiency of the magnet. It is obvious that the magnet should not be energized any greater percentage of the total time than is necessary in the efficient handling of materials. Very frequently operators will re-energize a magnet immediately upon dropping a load so that they can forget the magnet and give their entire attention to the movements of the crane. This can only result in reduced lifts as the magnet reaches an excessively high temperature. This point is of greater importance in those cases where the material is being transported a considerable distance, and some attention to it will pay dividends not only in increased lifting capacity of the magnet but in increased life of the magnet insulation.

Another disadvantage of energizing a magnet before reaching a pile is apparent when handling pig iron or heavy scrap. As an energized magnet is lowered on to a pile, some pieces are pulled end-up towards the magnet thereby preventing it from settling down evenly over the material. Tests have been made to prove that in handling pig iron 20 per cent greater lifts can be obtained if the magnet is permitted to settle down on the pile before energizing it. The objection might be raised that some additional time is required for the magnet to build up its flux. This additional time is of the order of two or three seconds. A study of the overall duty cycle will likely show that this loss of time is more than offset by the greater lift at each operation resulting in greater tonnage per turn. Where very short crane movements are made for each lift, it might be found more advantageous to energize the magnet before reaching the pile. In any case the study is worthwhile since it may result in equal or more tonnage with fewer crane movements resulting in less wear on the crane and less fatigue of the operator.

MISCELLANEOUS APPLICATIONS OF LIFTING MAGNETS

While the most common use of circular magnets is the handling of scrap in open hearth stockyards, the same type of magnet is used in handling skull-cracker balls. This load is one of low permeance because the pole shoes are not designed for close contact with the spherical ball, see Figure 11. While the general purpose magnet with a 50 per cent duty cycle coil is often used for this service, magnets are frequently designed with 75 per cent duty cycle coils in order to reduce the heating and maintain the ampere-turns at a more uniform level throughout the day. This cannot be done without a drop in the initial ampere-turns unless the coil space is increased. For a circular magnet of given diameter and fixed iron cross-section this increase in coil space can be obtained only by increasing the depth of the magnet. Consequently, special deep magnets having about 50 per cent greater coil height have been designed for this service. This allows the use of a 75 per cent duty coil without loss of ampere-turns for the same temperature

Figure 13 — Electric magnets are used to a great extent in handling coils.

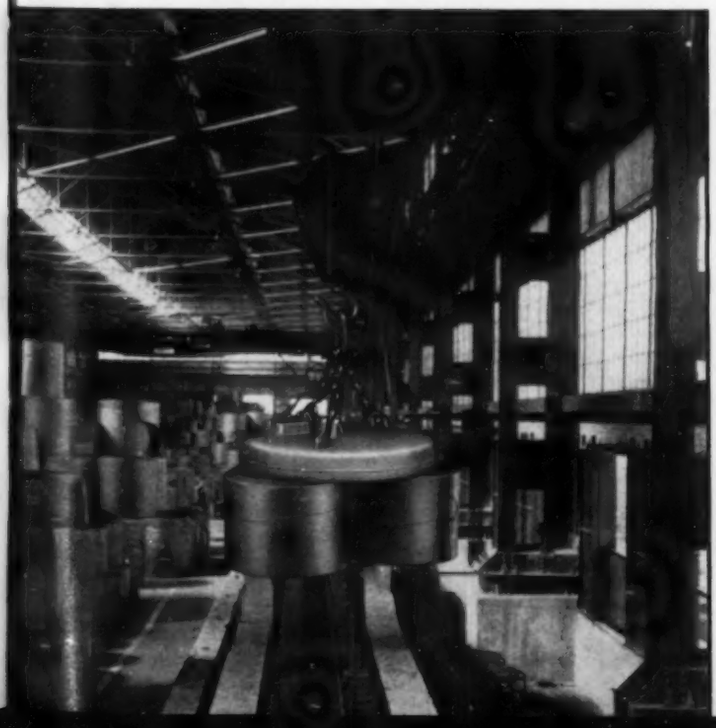
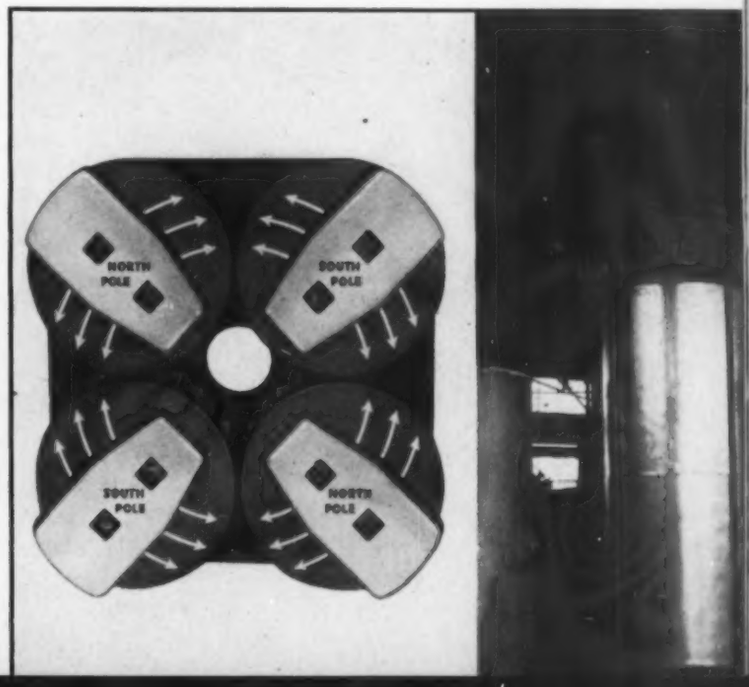


Figure 14 — The four-coil magnet was designed for handling strip coils.



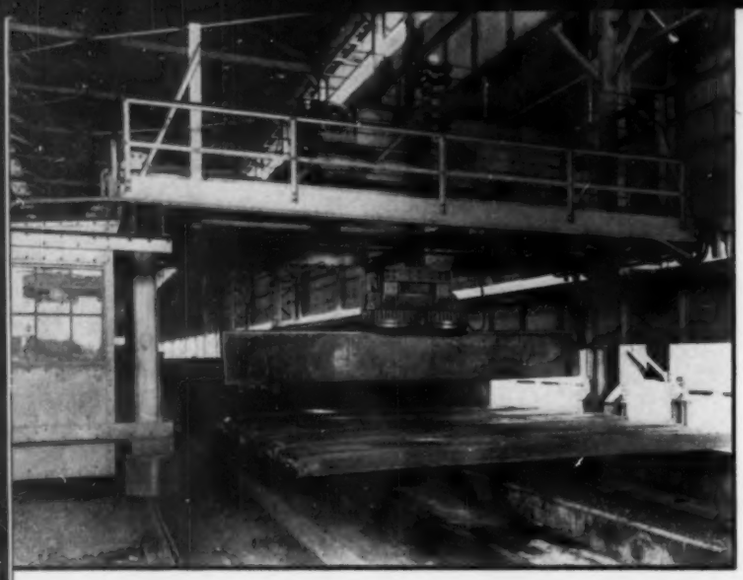


Figure 15 — Two circular magnets on a spreader beam are used for handling slabs.

rise. There is an economic limit to increasing the coil depth since the increase in coil surface is relatively small in comparison with the weight of added copper. Consequently, for constant temperature rise, the permissible increase in watts is determined approximately by the increase in coil area. For 50 per cent increase in coil depth the area of the coil and therefore the permissible watts input is increased about 15 per cent while the ampere-turns is increased about 30 per cent.

If a special purpose magnet were required for a very low permeance load such as steel turnings, it is obvious that increasing the ampere-turns by increasing the coil depth would add greatly to the weight of the magnet. In such an application it would be better to consider a reduction in the iron cross-section thereby automatically providing an increase in the radial length of the coil space. An increase in ampere-turns can be obtained in this way without any appreciable increase in the total weight of the magnet.

The circular magnet is also used in the mining industry for removing tramp iron from the conveyors on which coal and other materials are being transported to crushers. Such magnets are usually of smooth bottom construction without inner or outer pole shoes and have continuous duty coils. They are suspended directly over the belt or, preferably, over the head-pulley at the point where the material leaves the belt as shown in Figure 12. A magnet used in this way will not at any time have its iron circuit saturated so that the load may be considered one of very low permeance and the magnet may be designed accordingly. Because of the relatively low demand for such special purpose circular magnets, it is not customary to design them completely according to the permeance of their intended loads but rather to modify existing standard designs.

About fifteen years ago, with the advent of the continuous strip mill, a demand arose for magnets capable of handling coil strip steel on end. While circular magnets can be used for this purpose, especially in handling two or more coils simultaneously as in Figure 13, it was soon apparent that a special magnet would best serve the need or at least some modification of the pole faces of the circular magnet would be necessary.

Figure 14 shows a four-coil magnet designed for handling a single coil of strip steel. This magnet is a double bi-polar magnet so designed that the flux path is circumferentially through the coiled steel rather than radially as would be the case if a standard circular magnet were used. It is of interest to note that fifteen years ago a 15,000 lb coil was considered large, while today coils as large as 80,000 lb are contemplated.

While circular magnets are used singly or in pairs on spreader-beams in handling rails, pipe, slabs and billets as shown in Figure 15, many special rectangular lifting magnets have been developed for such materials and are used mostly in pairs. Figure 16 shows examples of such applications.

The problem of handling hot steel at a temperature around 1000 F presents some difficulty from an insulation point of view. In fact, the increasing demand for magnets for such service greatly accelerated the development of the thermo-setting compound mentioned earlier in the paper. Irrespective of the type of compound, it is recommended that a magnet used in handling hot steel be "dunked" in water occasionally not only to protect its insulation against excessive heating, but also to maintain the ampere-turns at as high a level as possible.

Magnets are often used in underwater salvage work where it is unusually difficult to prevent the entrance of water into the coil winding or the terminal boxes. This application, along with the realization that moisture is the greatest source of trouble with lifting magnets in steel mill service, has been greatly responsible for the design of the all-welded magnet with a steel clad hermetically-sealed coil.

Figure 16 — Special purpose magnets on a spreader beam are used for handling rails and billets.

DISCUSSION

PRESENTED BY

V. E. SCHLOSSBERG, Superintendent, Electric Power and Steam Departments, Inland Steel Company, East Chicago, Indiana

A. E. LILLQUIST, Supervising Engineer, Cutler-Hammer, Inc., Milwaukee, Wisconsin

K. L. JOHANNSEN, Assistant Superintendent, Maintenance, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

JAMES D. O'ROARK, Electrical Superintendent, Weirton Steel Company, Weirton, West Virginia

WALTER H. BURR, Superintendent, Electrical Department, Lukens Steel Company, Coatesville, Pennsylvania

GEORGE J. WALZ, Superintendent, Electrical Department, Bethlehem Steel Company, Steelton, Pennsylvania

F. W. JESSOP, Magnet Sales Manager, Ohio Electric Manufacturing Company, Cleveland, Ohio

R. W. GRAHAM, Electrical Superintendent, Bethlehem Steel Company, Lackawanna, New York

J. D. LEITCH, Chief Engineer, Electric Controller and Manufacturing Company, Cleveland, Ohio

V. E. Schlossberg: At Inland Steel we have approximately 150 lifting magnets. We service our magnets on a planned preventive maintenance program. We have one man in our electric shop who devotes practically all of his time to magnets, although there are times when he is on other work, and there are times when he has one helper.

We believe all the magnet builders have done an excellent job, and any of their standard magnets applied on standard service is a trouble-free piece of equipment. The great majority of our magnets are applied in this manner and are trouble-free, including the ones that are working under water.

Figure 18 — This improvised magnet design stood up well in mill service.

However, we have a few cases in our plant where the need is not for a standard magnet but for a rough-service magnet, and we call it rough service. It is not heavy-duty service but is actually rough service. In these locations we have used both the welded magnet, the conventional bolted magnet, and the combination bolted and welded magnet. All three types gave us short life.

Our organization thought to give us a longer life we would require the magnet supported not by the cover, but by the outer pole shoe, and the outer pole shoe would have to have more mass. In some cases these magnets are used not only as magnets but are also [illegible] for moving the steel by striking it. Here, we appreciate the absence of the remark: "What the [illegible] is a battering ram and not a magnet." For the oper[illegible] involved, the magnet even with the short life, was t[illegible] most economical way of doing the job. With the application of our rough-service magnet, we have cut the magnet maintenance on this service to a fraction of what it was with standard magnets.

Figure 17 shows a conventional magnet of the welded construction and in the service in which we were using this magnet, we usually broke off the lugs. We readily

Figure 17 — The lugs on this conventional magnet usually broke off in some types of steel mill service.

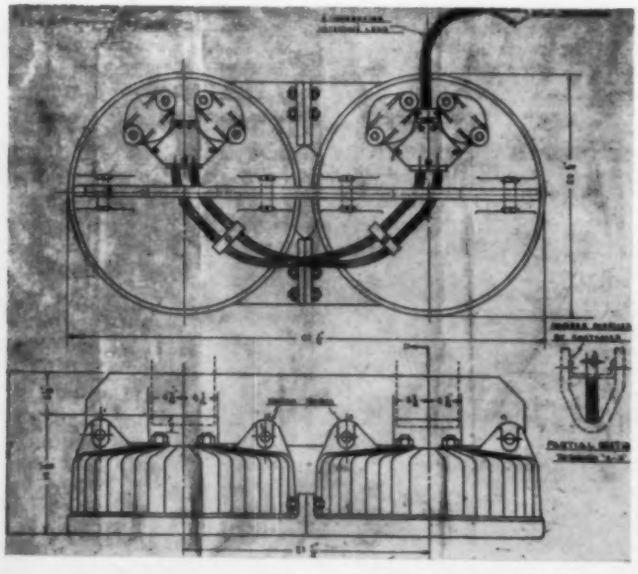


Figure 19 — With the improvised magnet frame, it is difficult to tell whose make of magnet is being used.

Figure 20 — In rough service, this 29 in. magnet gave trouble regardless of make.

Figure 22 — This is a conventional 65 in. magnet with a 6-coil design.

recognize that no one should ask a magnet to do that type of job.

Figure 18 shows our answer to that job. It is just a slab machined so the insides of standard magnet may be inside. Since we put it into service the magnet has given completely trouble-free operation.

Figure 19 shows the same magnet with another magnet manufacturer's insides. Both magnets perform equally well. Generally in our plant if we put one make of magnet on a certain job, one will say, "That is no good, give me another magnet" and the next fellow states, "That is no good, give me the original magnet." In this case as they could not tell whose insides were in the magnet, both worked equally well.

A conventional 29-in. lifting magnet which was on a very tough job is shown in Figure 20. We tried all makes and had difficulty maintaining all of them.

Figure 21 gives the answer to that problem. You will notice the magnet is supported by the four corners and they can batter the slabs around as much as they want to with the sides of this magnet. The magnet works equally well regardless of whose insides are in the magnet.

The chain life with the four chains is much greater than the chain life with three chains. We would like to call your attention that the four chains do not come together in a common shackle but there are two sets of shackles which have worked very well.

Figure 22 is a conventional 65-in. magnet of the 6 coil design.

Figure 23 shows a magnet supported from the outer yoke. We have severe service on our skull crackers as the building is lined with steel as shown.

This magnet has done a wonderful job. Previously we used 4-coil magnets in this location, and we used all three makes. Eight hours service was the maximum service we could obtain and have satisfactory operation. This 6-coil magnet is doing a great job on continuous service.

In closing our discussion, we would like to say to the magnet designers or magnet builders that for standard service, either the bolted or welded magnet will give as good if not better service than any other piece of steel mill electrical equipment. The bolted magnet is easier for us to service if we do encounter trouble, and the rough-service magnet which we have shown you has a longer service life than either the bolted or welded magnet. However, it should be applied only on a special rough-service job.

A. E. Lillquist: Manufacturers have for years

Figure 21 — When the 29 in. magnet was mounted inside the frame shown, it could stand much battering with little trouble.

Figure 23 — The magnet design shown has stood up on continuous skull cracker service in a steel-lined building.

given serious thought to welded magnets. As pointed out by Mr. Leitch, the welded construction has certain advantages. However, if a magnet must be dismantled for any reason, or if a pole shoe must be replaced, consideration should be given to the following points:

1. The magnet must be set up in a large boring mill or similar machine in order to open the welds. Not all users, not even all steel mills, have the necessary equipment to do this work.
2. When the magnet is re-assembled in the field, the pole shoes must again be welded to the body. Most users will not have welding fixtures to do a fast and good welding job. That means that the cost of welding may be appreciable compared to the cost of assembling shoes on magnets of the bolted construction.
3. Magnets in service, as shown in the figures of Mr. Schlossberg's discussion are subjected to terrific battering and hammering. Therefore, the welded joints must be strong, but above all they must be ductile. That means that not just any welding rod or any welder can do a satisfactory job on the magnet. I have seen magnets returned to the factory for repairs on which the user welded the outer pole shoe to the body. In most cases the joint was broken in the weld, probably due to the use of improper welding rod or improper technique. In other cases it was almost impossible to machine off the weld, because it was so hard.

The charts shown by Mr. Leitch indicate the tremendous importance of duty cycle on magnets. A 150 C rise on a magnet coil is admittedly high, because that is the average rise by resistance. However, if a magnet designed for one half time duty is used on a 65 or 75 per cent time-on cycle, the temperature rise will greatly exceed this 150 C average, and hot spots which reach the danger point may develop.

When a magnet fails apparently due to moisture, the user thinks that moisture has entered the magnet at some joint. In some cases that is true, but not all moisture failures are caused by moisture from the outside. If the temperature in the coil is excessive, there will be deterioration of the insulation, and probable distillation of water crystallization and even water of decomposition. Electrolysis or ionization may result causing failure of the winding. I believe a large per cent of magnet moisture failures are due to excessive temperatures resulting from too severe duty cycles. Because high temperatures are dangerous to a magnet, it is very important that the crane operator be trained not to energize the magnet before the magnet rests on its load.

K. L. Johannsen: At present we are using only the bolted type magnet and the bolted and stitch-welded type, but we expect to put into operation within the next month a welded and bolted magnet on 40-ton locomotive cranes, duplicate cranes that will be handling scrap and pig iron under similar operating conditions. Assuming that these magnets will come into the shop for service sooner or later, we hope to see for ourselves some of the merits or disadvantages claimed for the all-welded magnet.

I would like to ask one question. These new cranes that we are contemplating putting into service are designed to increase the pickup voltage from 10 to 15 per cent during the pickup portion of the duty cycle. Do you consider this advantageous from an over-all standpoint, or will this cause undue heating, which will of course decrease the lifting effect? Will it cause the insulation to deteriorate, and is it worth the additional equipment?

James D. O'Roark: Assuming that the basic design of any magnet that you purchase is correct and that you have chosen the correct magnet for the job, then the next concern after you put the magnet in service is, "How long will it last?" I think most of us are of the opinion that magnets are expensive tools to begin with. In our Weirton works we have approximately 50 magnets, mostly of 65- and 70-in. size, and in the earlier designs, where our maintenance troubles consisted of broken bolts in the pole pieces, replacing the magnet chains, grounded coils, and the usual faults of the older designs, we attempted to repair our own magnets. After several years of concentrated effort, we decided it was a job for a specialized shop, either the original manufacturer or some service shop such as the larger companies maintain here in Pittsburgh.

Once the mechanical design of the magnet is set, and properly proportioned, there is little that goes wrong with the frame or the metallic portion of the magnet. I think I am safe in saying that probably 80 per cent of any succeeding trouble is in the coil itself.

It is very evident that much progress has been made in the building and insulating of the magnet coil. However, I believe it still warrants the greatest study and attention because, as I say, most of the succeeding trouble develops in the coil.

I do not know what the policy of the manufacturer is in keeping a close record of magnet failures. However, I think it would be very worthwhile, particularly here in the Pittsburgh district where a lot of magnet repair work is done in the larger service shops, for the manufacturers to investigate the records of these shops, and I am sure there would be no objection to diagnosing the coil failures. In other words, are most of our coil failures between turns? Are they between layers, or are they between coil and ground?

I did not hear Mr. Leitch say whether the silicone insulations as used in modern-day insulation entered into the magnet coil design or not, but I feel that the biggest improvement that can be made in increasing the life of a magnet can be made by a constant study of the coil failures, and by applying corrective design and improved methods and materials of insulation.

Walter Burr: We at Lukens are faced with a problem similar to that in most of the steel plants, that is a shortage of pig iron. Necessarily, we must handle more scrap, and the problem of getting the greatest amount of this scrap possible into the number of pans available is one which is giving us a certain amount of concern.

I have been told there has been some work done in connection with the proportioning of the magnets and the location of the coils so that we can hope to get the scrap to aline itself on the face of the magnet in such a way that when it is dropped into the pans, it will fall in longitudinally and not crossways of the pans.

George J. Walz: I would like to say, that only a few miles from the steel plant, with which I happen to be connected, there is located another fair sized steel

plant, which has been receiving assistance from us from time to time on their more special and difficult repair jobs, since their repair facilities are somewhat limited.

Several months ago, their electrical superintendent called me up and said that he had a 65-in. lifting magnet, which had failed inside of the coil and would have to be rewound, and asked whether we could do the job for him. Our shops were so hard-pressed at the time, that it was simply impossible for me to grant this request. It was then that I realized, more than ever, that the investment being considered, the electric lifting magnet is probably the greatest labor-saving device in the steel industry today. Can you imagine with the cost and attitude of labor being what it is today, any steel plant attempting to load, unload and otherwise handle pig iron, scrap steel, etc., in any and all kinds of weather, by hand, as it was done forty years ago?

I can readily understand the statement made by one of the men here, a few minutes ago, that they had tried the job of rewinding large lifting magnets, and finally had to give it up. It is, without a doubt, an extremely difficult repair job, mainly because the equipment required is so highly special. It required considerable time and effort on our part to design and construct the proper equipment but we now have this and can do a first-class, permanent rewinding job in our own shops.

The hermetically-sealed coil, which Mr. Leitch has just described in his paper, is, I think, a mighty fine feature and is the most valuable improvement brought out in lifting magnet design during the past generation. The all-welded magnet cases, even though they may be somewhat more difficult to repair, are also a step in the right direction for the following reason. For about 20 years it has been our practice to weld the pole shoe to the case on all of our magnets with about six large welds spaced around the circumference. Since we began this practice, our records prove that our rewound magnets have stood up quite a bit better than new magnets. This was certainly not because we could do a better rewinding job, or even as good a rewinding job as the factory. It was, without a doubt, only because the pole-shoes could no longer work loose and eventually wreck the magnet.

We have at our plant about 80 lifting magnets, mostly of the larger sizes, and, considering the extremely rough, hard, continuous duty to which they are subjected, they give us really remarkably good service. This is partly due to the fact, that we have, control of the magnet operators, we always have several spare magnets on hand, and we have good rewinding equipment and personnel.

F. W. Jessop: I have been a magnet manufacturer, but I have tried to view this thing from the standpoint of magnet users, and I think Mr. Leitch and his company have started something that is worth going through with and testing out, and it will probably take five years to determine. However, I would have certain limitations if I were a buyer and certain reservations. I would buy that type of magnet only for uses which involved severe abuse, and I would weld only the outer ring, because I have heard from steel men that the center pole actually wears out and has to be renewed more frequently than the outer ring, and if you bolt it then it is an easier job to do it.

I would also limit it to the 55- and 65-in. sizes only, because the smaller sizes are so light that even if they are used as a battering ram, they cannot be abused because they are light.

A welded magnet undoubtedly would cost more to repair, and therefore should only be used by people who are big enough to own a boring mill and who have welding ability and can do the work themselves. Otherwise, they are liable to be up against a delay of something like a month, or maybe more.

I want to say, although I have no proof, that in view of the high heat involved, because of bringing out the leads, no matter what sealing compound is used, any magnet will "breath," and if it is in a moist place it will breath moisture.

I have one other objection to the design presented and that is that the outer ring weld is at the maximum diameter, which is the point that will get the abuse, and if that is bent in, even a boring mill will not take out all the weld and it will have to be chipped out.

R. W. Graham: The new all-welded magnet is so streamlined that it looks more like a skull cracker or battering ram, and so appeals to the operating man for just such duty as it appears "indestructible."

He little realizes the fight going on between induced voltages and insulation to ground. We must admit and perhaps accept this as a function of a magnet, and the designer should certainly give consideration to this requirement.

The operator of today will often continue to operate a magnet after an improper functioning of the control, such as discharge resistor opening, and there should be some means to prevent such operation. The magnet should be inherently protected if control does not function properly.

Someday, someone is going to develop a "breaking link" at the terminals of the magnet to prevent failure due to improper functioning of control, or the sudden shearing of collector tag line.

J. D. Leitch: I wish I had answers for all of these questions. I was very much interested in Mr. Schlossberg's pictures of the special magnet designed for exceedingly severe mechanical abuse. I noted well what he had done. I was particularly interested in the 4-chain mounting and in the manner in which he fastened the supporters at the outer pole shoe.

The policy of planned preventive maintenance of lifting magnets at Inland Steel Company is commendable. Over a period of years it should prove worthwhile in reducing maintenance costs and outage time.

In answering Mr. Lillquist, a boring mill is necessary in removing the pole shoes. We realized that the smaller users of magnets, such as scrap yards, do not have boring mills with which to repair their own magnets. It has not been the practice of any of these smaller users to repair lifting magnets at any time since they are without the other necessary facilities.

When replacing worn-out pole shoes on magnets of bolted design, it is customary to find an accumulation of rust and scale which necessitates, in our opinion, a light boring-mill cut on the magnet case to assure proper seating of the new pole shoe. Very frequently the bolts are so rusted in place that they can be removed only by burning them out. No doubt Mr. Lillquist has encountered these difficulties in the repair of bolted

magnets. The only users of lifting magnets who do their own repair work are the large steel mills, and I know of no plant of any size that does not have one or more boring mills.

Mr. Lillquist also brought up the question of rewelding in the field. He is quite right, it requires a good welder and special welding rods. New problems are always presented by any new design, and I agree with one of the gentlemen, I believe it was Mr. Jessop, who said that with a few years experience, most of these things will be ironed out.

The welded magnet has taken very severe abuse in many applications. No doubt many of you have them in service and know this is true. The weld should be ductile. It is not easy to make welds that are really ductile. We have consulted with welding engineers extensively on this welding problem, resulting in very satisfactory welding technique which, of course, we make available to all interested parties.

I know from experience with magnets that have been returned to us for repair that the most frequent cause of coil failure is moisture entering the coil at some of the joints. The thought expressed by Mr. Lillquist, that the presence of moisture is the result of high temperature breaking down the water of crystallization of the insulating materials is a new one to me. I would hardly think the temperature of a lifting magnet would be sufficiently high to free the water of crystallization. I am not saying that it might not be one of the causes we have overlooked, but when we have very good evidence that the water has come from outside the magnet, we have not considered less obvious causes.

Mr. Johannsen brought up a very good point. What would be the effect of increasing the voltage 10 or 15 per cent for a short interval while picking up a load and then inserting a resistor to reduce the ampere-turns and the heating? This has been done successfully a number of times with an increase in the lifted load and some reduction in the total heat dissipated by the magnet. The increased power supplied to the magnet during the short "pick-up" interval is more than offset by the lower power after insertion of the resistance. This is possible because once a load has been picked up, it takes less current to hold it than it did to pick it up initially. The added complication to the control equipment and the additional resistance and its mounting must be considered. The added cost, in my opinion, can often be justified. The idea is a sound one; we use it frequently in the control of contactors, relays, solenoids, and magnetic brakes.

Mr. O'Roark of Weirton Steel Company said that in his opinion most magnet failures occurred in the coil. I agree with Mr. O'Roark and go farther to say that most of these failures are caused by moisture getting in through the terminal boxes. A cable snarls and breaks; someone replaces the leads with a temporary set in such a way that water fills the terminal box. That is where preventive maintenance should be employed. The coil does not fail until water gets inside.

The insulation of magnet coils has been improved and will continue to be improved as new and better materials become available. Silicones are one of the possible directions in which we might move. In our compound which has four ingredients in it, two of them make a very good thermal-setting varnish which we use between layers, and this with two added ingredients gives an excellent compound for filling the space around the outer part of the coil. The thermal-setting varnish and compound are far superior to anything we have used in the past.

We have always kept as accurate a record as possible of all magnet failures. It is from such records that we learned what not to do in designing the new magnet.

Mr. Burr of Lukens Steel brings up a difficult problem. How can we handle pig iron with a magnet so that it will pile up uniformly when it is dropped? If we could pick it up uniformly we might have a better chance of setting it down uniformly by letting the magnet and its load come to rest on the floor before de-energizing the coil. I do not see how we can pick it up uniformly unless it were piled that way initially.

I agree with Mr. Walz of Bethlehem Steel Company that the idea of welding the outer pole shoes is not new. We too have been welding the outer pole shoe on some of our smaller magnets for about ten years with notable increase in magnet life.

I wish to thank Mr. Jessop for his remarks and for his progressive attitude. It is quite true that a five-year period will tell us a great deal about the all-welded magnet. We have, however, accumulated much information during the last ten years on partially welded magnets that prompted us to go forward in that direction.

Mr. Jessop suggested limiting the use of welded pole shoes to the outer pole only and to the heavier magnets only where the abuse is greatest. If it is good design on the heavier magnets, why not on the smaller and lighter magnets? As I mentioned already, our experience with 25 and 29 in. magnets is the basis of extending the all-welded design to larger sizes.

In connection with Mr. Jessop's objection that the outer pole weld is at the maximum diameter of the magnet and thus subject to severe blows, I should like to mention that the blow is not carried by the weld but by a heavy shoulder on the case. We have had no trouble in machining away the weld when replacing an outer pole.

In the paper I mentioned "breathing" as quite important in causing moisture to enter the terminal boxes and the coil. With the old thermo-plastic compound such as asphaltum, it was necessary to provide expansion chambers to take care of the expansion and contraction of the compound with change in magnet temperature. In the new design of magnet employing a thermo-setting compound, the expansion and contraction is practically zero so that breathing is of much less importance.

Mr. Graham of Bethlehem Steel Company brings up a very important point. He is asking for some protective device or means which will limit the induced voltage during the interruption of the circuit to the magnet. The magnet controller is designed with this idea in mind, but if it is not functioning properly no indication is given until the damage has been done. Even if the control is in good condition no protection is provided when a cable is sheared. There is definitely a need for some protection against high induced voltage at the magnet terminals. The problem is certainly worthy of investigation.

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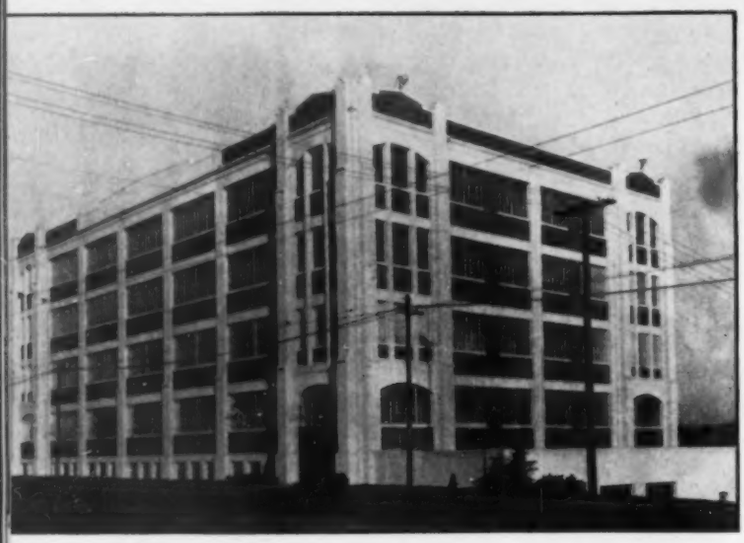


New research laboratory of the Oliver Iron Mining Company makes use of an existing building which was remodeled for laboratory use.

▲ TACONITE, the siliceous and iron-bearing rock which generations of miners have rejected for richer ore bodies in the Lake Superior region, is destined to become a keystone ore source for the steelmaking furnaces of America.

With the objective of conducting a long-range study to develop commercially useful concentrating methods, Oliver Iron Mining Company, United States Steel's ore-producing subsidiary, has established a new research laboratory at Duluth, Minnesota. This latest addition to its research facilities still further extends the studies of ore beneficiation sponsored by the Oliver company through its more than half a century of existence.

In the past the ore supply available from the Lake Superior district has consisted of high-grade underground and open pit "direct-shipping" ores, provided in concentrated form by nature and supplemented by varying amounts of concentrates produced by relatively simple processes. This type of ore supply can be expected to continue, although in gradually reducing volume, for a long time to come. The exact length of time depends upon the demand for and the industrial absorption of iron and steel products.

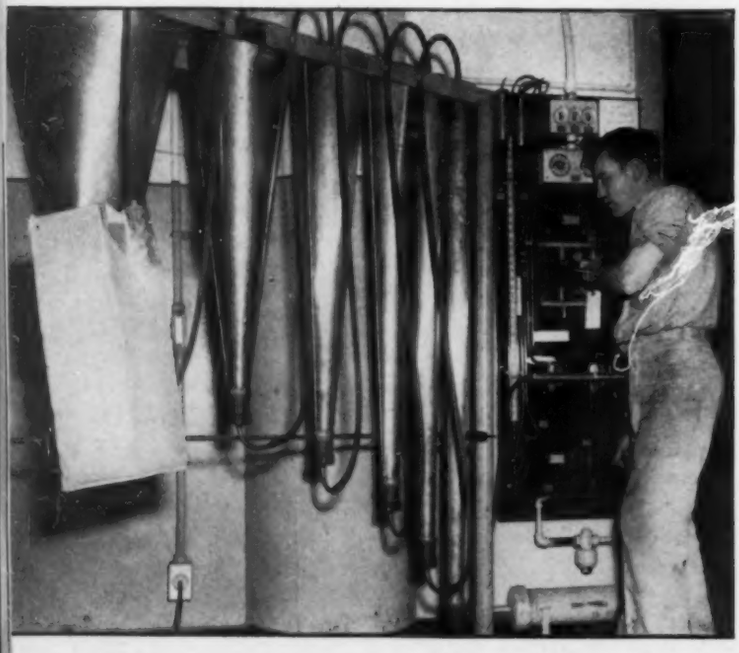
Concurrently, the future supply from this region will contain increasing proportions of high-cost underground ores and high-cost concentrates while the proportion of direct-shipping open pit ores will decline. Ultimately the Lake Superior ore supply will consist largely of concentrates, together with a moderate proportion of underground direct-shipping ores.

The concentrating processes of the past are reasonably simple. Wash ores are dressed with little preliminary crushing, followed by washing away the excess sand. While the iron and sand contents of some other ores are more intimately associated, the problems of crushing and washing have been easily met.

Taconite, however, is the hard rock in which the ores of the Lake Superior region are found. Iron ore, in fact, was derived from this rock during eons of natural chemical leaching. What nature took her own time to achieve, the mining industry now seeks to do by dressing operations measured in thousands of tons in a single hour.

Since, broadly speaking, taconite contains only 25 to 35 per cent iron, the rock must be crushed and then ground to a powder as fine as ordinary cement before the valuable iron particles are freed from silica particles and can be separated for easy concentration. Moreover, taconites vary widely in chemical composition and the nature and distribution of iron content.

The infrasizer is used to screen fines smaller than 200 mesh. Size separations are made by passing a current of air through cones of increasing size. The air velocity becomes smaller in the larger cones so that in each cone, the heaviest portion only, settles at the bottom and does not pass on to the next larger cone.



Since the iron particles in taconite may be either highly or weakly magnetic, the two most common types of separation considered are magnetic separation and froth flotation.

The batch laboratory is equipped with many types of magnetic separators, but for small samples a simple oscillator is used. This device consists of a long glass tube, filled with water, into which a sample of perhaps 5 grams of ground taconite is introduced. Magnetic particles soon gather on the inside of the tube within the magnetic field, while the sand dross settles from the shaking action and passes out through an opening in the bottom of the tube.

If the iron oxide is a hematite, which is only weakly magnetic, froth flotation is used generally. In one such test a sample of powdered taconite is introduced into soapy water through which air bubbles are blown. The iron particles attach themselves to the froth while the sand sinks into the underlying water.

If batch tests show promising results, a laboratory pilot line with an hourly capacity of perhaps 100 pounds may be set up to round out concentrating methods and

elPushes

ERESEARCH

to establish the value of the particular type of rock as a source of iron. Data from a large number of core samples from a specific taconite body are studied statistically to estimate the value of deposits in a given area. If the tests thus far are promising, further investigations are transferred to the pilot plant area of the research laboratory. Here, any type of concentration pilot plant can be set up, but production is limited to about 1 ton an hour.

Taconite is delivered now in larger quantity — by railroad car to an adjacent storage yard. From there it is transported into the laboratory building, where it is crushed and screened to the fineness indicated for given experiments.

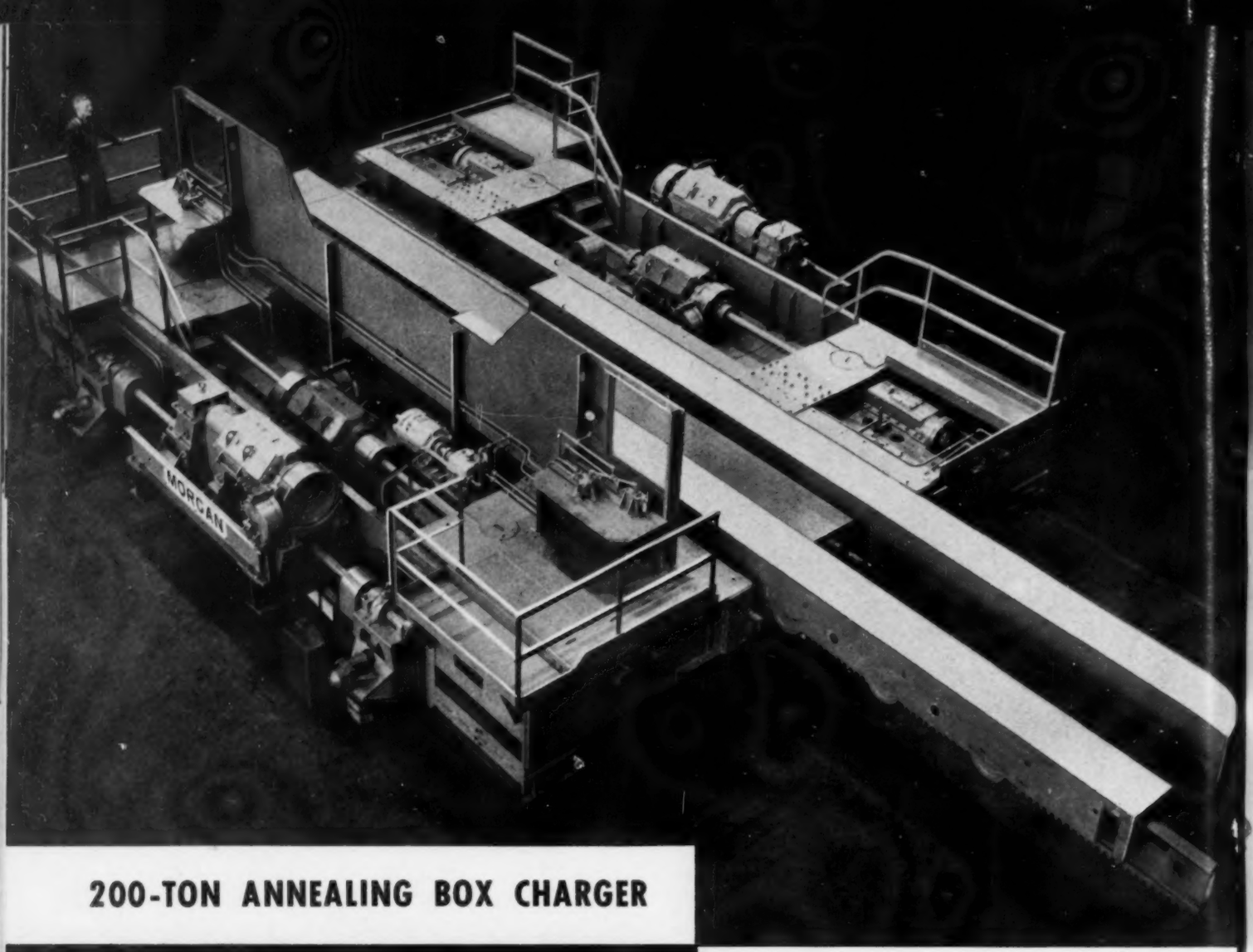
The pilot plant test area is surrounded by vertical steel columns, each carrying equally spaced brackets which serve as supports for beams and cross-members at any desired level. Floors may be provided at the various levels by installing subway gratings on the beams and cross-members. The equipment for the pilot plant experiments is assembled and installed at proper floor levels. An experimental pilot plant may include arrangements of widely varied equipment, such as rod mills or ball mills, in which loose steel rods or balls in rotating cylinders further reduce the size of the material; screens to separate fine from coarser material, gravity concentrators, which function according to the rate of settling of materials of different specific gravities in water; magnetic separators and flotation machines.

Each step of taconite investigation in this research laboratory is separated from the next and larger step by practical "ifs."

If the mineralogical examination of a core sample indicates sufficient iron content in the region from which the specimen came, the batch laboratory undertakes grinding and crushing, magnetic separation, froth flotation and other tests.

If the batch laboratory tests show a sufficient quantity of iron may be reclaimed economically, the individual parts of a suggested concentration process are rounded out for the particular type of rock. Assuming promise, the technicians may set up a miniature pilot line, with a productive capacity up to 100 pounds of concentrate per hour. If this line succeeds, action begins in the larger pilot plant area. Equipment is drawn from the storage area and installed. Taconite arrives in quantity to produce as much as a ton of concentrate per hour. If the pilot plant develops an economical process, a still larger plant may be constructed at the ore site where the original core samples were found, and still larger production is undertaken.

The pilot plant area extends from a well in the basement to the ceiling of the first story.



200-TON ANNEALING BOX CHARGER

BUILT BY MORGAN Engineering

Illustrated is a Morgan 200-Ton, 5-motor, 19′-3½″ Span Annealing Box Charger. It consists of a traveling bridge upon which are mounted two rack driven charging trucks operating in unison for raising the annealing boxes and moving them into or out of the furnace or onto the cooling beds. The charging trucks are operated by two motors through four worm units with provision for operating either of the two motors alone.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

NEWS SUPPLEMENT MAY, 1948

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

RELIANCE ELECTRIC EXPANDS FACILITIES AT CLEVELAND AND ASHTABULA, OHIO

▲ Conversion of one of its smaller manufacturing plants in Cleveland into an engineering, development and service center gives Reliance Electric and Engineering Company enlarged quarters in which to expand basic development activities covering 1 to 400 hp motors and speed control equipment.

With product development, design and tool engineering functions and facilities concentrated in one building, the company's engineering efforts have been coordinated to a far higher degree than was previously possible, according to William R. Hough, chief engineer. Reliance, as a result, is thus better equipped, engineering-wise, to serve key industries in which the company's motors and adjustable-speed (V*S) drives continue to find a steadily widening range of application.

Completed and put into operation on July 1, 1947, the new Ashtabula, Ohio, plant of Reliance was built for the manufacture of a-c and d-c motors up to 20 hp in size.

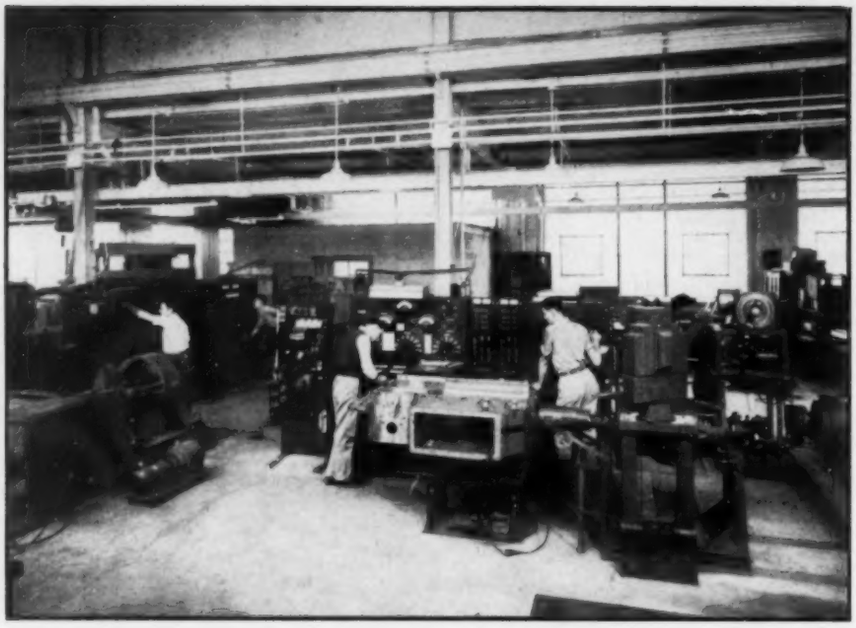
Remodeled at a cost of approximately $100,000 and including 35,000 square feet of floor area, this new facility is the third of a series of projects in Reliance's postwar expansion program. Others, completed since 1945, have been: (1) the 54,000 square feet of warehouse space and material handling equipment for Ivanhoe Division which was finished in 1946 and has since more than justified itself both in lower costs and more production, (2) a new $1,500,000 plant in Ashtabula, Ohio, where a-c and d-c motors from 1 to 20 hp have been coming off the line in increasing quantity since August 1947, and (3) the improvement of manufacturing operations in Cleveland with the installation of a number of new high-speed machines in the plants.

The engineering, development and service center represents a practical realization of what Reliance terms an "applied engineering approach" to the problem of producing an integrated group of electrical products — integral sizes of a-c and d-c motors, and variable-voltage drives, including rotating and electronic types. Such units, Mr. Hough points out, are best engineered under a set-up where a close coordination can be achieved of all elements going into the new design.

Reliance manufacturing practice is organized on the basis of a three-way production split: small motors (Ashtabula), large motors (Ivanhoe division, Cleveland), and controls (marine division, Cleveland). Each product line, being highly specialized in its own right, has a separate design staff. Thus, with specialized manufacturing facilities in each instance related to product design, the activities of the three design engineering groups are better coordinated by concentrating them together at one point. This is made possible by the new engineering quarters.

Also back of the decision to group engineering personnel and facilities in one building was the company's desire to do a complete, overall job of engineering, design and development of its products and their components. Concentration of product development with an engineering laboratory

New presses, equipped with Reliance adjustable speed drives, have had their output trebled. Plug-in type bus duct (on wall in background) runs nearly the entire length of the plant to facilitate connection of machines to power source.



Generator and alternator equipment, housed in the basement, is controlled from a central power distribution board in the general experimental laboratory.

and tool design with a tool room accomplishes this objective.

Product development includes consideration of tooling required based on the most efficient methods of manufacture. The tool room, with its 5000 square feet of floor space, serves this dual purpose. It houses 55 production-type machines ranging from electric and gas welders, drill presses, surface grinders, 42 in. vertical turret lathe and a jig borer to an optical comparator.

ASSOCIATION OF IRON & STEEL ENGINEERS
1010 Empire Building, Pittsburgh, Pa.
ATlantic 6323

NEW ASHTABULA PLANT

Completed and put into operation in July, 1947, the new Ashtabula, Ohio, plant of Reliance Electric and Engineering Company was built and equipped expressly for the manufacture of a-c and d-c motors up to 20 hp in size, power units for pre-engineered, packaged adjustable speed (V*S) drives so widely used throughout the nation's basic industries, and for the production of related electrical equipment.

Of simple functional design giving it a trim, clean-cut appearance, this new facility, 480 ft long and 250 ft wide, supplements other Reliance plants in Cleveland, Ohio. Dictated by the company's urgent need for postwar expansion, the Ashtabula factory cost $750,000. Addition of approximately $750,000 more for the specialized equipment installed, including several new units, makes this industrial operation the "latest word" in modern motor manufacturing.

Employing 500 workers and providing a manufacturing area of 120,000 square feet, this single-story steel-frame building, with curtain walls of brick veneer on a concrete block backup, is distinguished by the effective integration of a compact equipment layout, continuous production flow system, mechanized materials handling techniques, overhead-mounted utility service facilities, an improved type of ventilation, and a comfortable working environment for both office employees and plant personnel.

Following a number of studies, the company decided to erect a building of the conventional structural steel frame type, with trussed construction providing aisles 50 ft wide and bays 40 ft long. Required area totaled approximately 120,000 sq ft. Five aisles, each 480 ft long, it was determined, would accommodate the production lines needed. There is one column for each 2000 sq ft of floor area.

Running through the center of the plant is a monitor that not only provided room for crane travel, but also afforded an opportunity for installation of fixed sash to supplement lighting facilities serving this particular area.

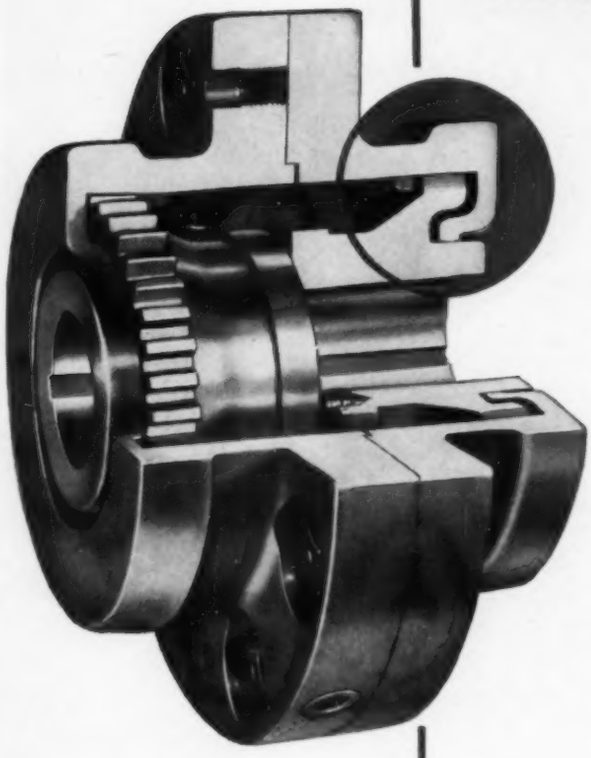
As a result of these provisions, a functional production sequence highlights operations here. From receipt of raw material, through its fabrication and processing, to packaging and shipment of the finished product, there is little back-tracking or retracing in materials movement. Conveyorized and mechanized equipment, neatly integrated with this straight-line flow, saves man-hours and conserves manpower in handling raw materials, semifabricated assemblies, and finished products. This combination of uninterrupted, smooth-running manufacturing sequence and time-saving materials handling facilities, Reliance officials point out, makes possible the twin advantages of uniformly high overall efficiency and consistently low unit costs.

Materials handling operations are performed with a variety of equipment. On production lines, in carrying motor parts and V*S Drive power unit assemblies from one operation to another, gravity-feed roller type and overhead-trolley type conveyors are used. Individual machine tools and work stations are served by their own jib cranes; no heavy lifting by workers is required on any production job. A fleet of gasoline and electric-powered lift trucks facilitates handling of raw materials, fabricated parts and finished products. Two cranes of three-ton and five-ton capacity respectively in the center aisle serve the bar stock and sheet metal storage areas.

Ample space is provided for receiv-

An OLD Story in Weirton's NEWEST Plant!

FAST'S self-aligning Couplings Again Chosen for the High-Speed Cold Strip Mill



When any company chooses a product time after time, year after year, it must be good! And Weirton Steel Company has been specifying Fast's self-aligning Couplings for well over 20 years! The latest Fast's to be installed is handling a punishing job on the new high-speed cold strip mill with a capacity of 5000 feet per minute.

Like Weirton, you can forget about coupling shutdowns once you've installed all-steel Fast's Couplings. There's nothing to wear, nothing to fail in a Fast's. Even the load-carrying oil is protected by an exclusive "rocking bearing" (circled). This bearing is *exclusive* in providing a positive metal-to-metal seal against moisture, dust and grit . . . and is also exclusive in its correctly engineered position which allows *freedom of movement* to compensate for misalignment, because its *spherical* base has the *same axis* as the hub spline faces. No perishable packing rings are used.

We have a complete line of couplings. When you buy Fast's Couplings, you buy years of top engineering experience, Koppers' high standard of workmanship, and unexcelled service that insures spare parts, no matter how old the couplings may be. For full information, mail the coupon below to: Koppers Co., Inc., Fast's Coupling Dept., 215 Scott St., Baltimore 3, Maryland.

* *Weirton specifies Fast's Couplings*

* *Fast's Couplings are a preponderant majority of all flexible couplings for Weirton mills and equipment.*

K KOPPERS

FAST'S *self-aligning* COUPLINGS

KOPPERS COKE OVENS AT WEIRTON, TOO!

Koppers has recently completed construction of two batteries totaling 106 Koppers-Becker Ovens for the By-product Coke Plant of Weirton at Weirton, W. Va., rated to carbonize approximately 2600 net tons of coal per day. Koppers engineers designed and constructed the first battery of byproduct coke ovens operated by Weirton in 1922.

SEND FOR FREE CATALOG!

Gentlemen: Please send me your illustrated, informative catalog, giving full information on the many types of Fast's Couplings.

Name.....

Company.....

Street.....

City..... Zone..... State.....

A NEW BAR AND TUBE TURNER

✓ . . . automatic centering with roll-type positive, continuous feed

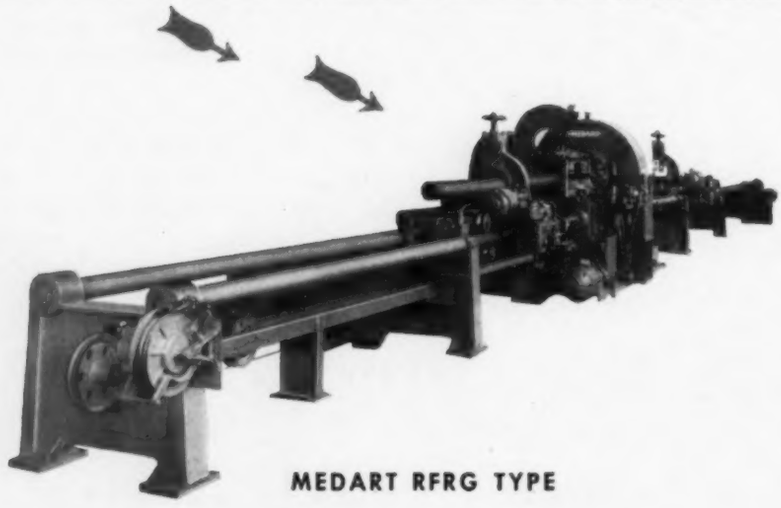
✓ . . . separate drives for cutting tool and bar feed for infinite ratios

✓ . . . two individual automatic-grip carriages

✓ . . . production on rough peel or precision work

✓ . . . 100% chip recovery

The new Medart RFRG type turning machine gives the exact ratio between cutting speed and bar feed rate for superior finish and close tolerance in precision turning, and high production on rough peeling or scalping. Speed and range of materials turned is limited only by the capacity of present day cutting tools. This new machine is completely push-button operated, and its improved, direct drive is actually simpler . . . easier to operate!



MEDART RFRG TYPE

MANUFACTURING ENGINEERS OF COMPLETE TRANSMISSION EQUIPMENT AND SPECIALIZED MACHINERY

MEDART

THE MEDART COMPANY — 3540 DE KALB ST. ST. LOUIS, MO.

ing and dispatching shipments via railroad or highway. Rail and truck areas are depressed, permitting all material to be received at floor level and loaded or unloaded from freight cars or trucks directly onto lift trucks and palletized equipment. These areas also have crane facilities.

NEW MOTORS

A new gearmotor and a new monel-clad, corrosion-resisting chemical motor, both designed to solve difficult machinery drive problems, were announced on April 6 by J. W. Corey, president of Reliance Electric and Engineering Company.

Manufacture and sale of the new gearmotor represent a joint cooperative endeavor by Reliance and Philadelphia Gear Works, Inc. of Philadelphia. The latter concern will cut and assemble the gears for the unit while Reliance will supply the motors. Both companies will sell the finished product.

"In teaming up with Philadelphia Gear as our partner in the manufacture and sale of this new gearmotor," Corey said, "we at Reliance feel we are joining forces with a company whose reputation for fine workmanship is unexcelled and whose plant facilities are ideally suited to the building of this product."

Russell C. Ball, president of Philadelphia Gear Works, said, "we have told Reliance that we will be ready to assemble gears and motors into a finished product by the end of June and we intend to keep that promise. In addition to building tools and patterns for the manufacture of the gear trains, we are in the process right now of completing an addition to our Philadelphia plant which should enable us to get into substantial production with very little delay."

WHEELING TO INSTALL LARGE OXYGEN PLANT

▲ Wheeling Steel Corporation and Linde Air Products Company have completed arrangements for Linde to install a large, low-purity oxygen plant at Wheeling's Steubenville, Ohio, steel mill. Linde's plant will produce approximately 135 tons of oxygen a day to be used for metallurgical purposes mostly in the open hearth furnaces.

Wheeling Steel has been experimenting with oxygen in their open

hearth furnaces for some time. On the basis of the work done so far, the Wheeling management has concluded that the use of low-purity oxygen will result in an effective increase in steel production at the Steubenville mill. These conclusions are based on their particular circumstances such as furnace design, operating practice, and types of steel produced.

This is the second contract that Linde Air Products Company has made involving tonnage low-purity oxygen. Although this type of plant is new, the designs are based upon more than 15 years investigation of low-purity oxygen production. As a matter of interest, Linde has also operated for more than 18 months a pilot plant with a capacity of between 175 and 200 tons a day of 90 to 95 per cent purity oxygen. This production is entirely from one column, which is believed to be the largest single unit for the production of oxygen that has ever been constructed. The experience gained in this full-scale operation will be carried over into the design of the Steubenville plant.

Wheeling has concluded that the use of low-purity oxygen will result in an effective increase of production.

J & L TO TAKE CONTROL OF THREE SUBSIDIARIES

▲ Jones and Laughlin Steel Corporation, a Pennsylvania corporation, announced lately that it is registering to do business in West Virginia as a foreign corporation. The reason for this action is to take over the operations of three of its subsidiaries which are presently engaged in the production of raw materials in West Virginia. The three subsidiaries which will be dissolved are: Blair Limestone Company, a Pennsylvania corporation, which for the past thirty-one years has been engaged in quarrying limestone and dolomite in Jefferson and Berkely Counties, West Virginia, principally for use in the parent corporation's furnaces; Black Eagle Smokeless Coal Company, a West Virginia corporation acquired by Jones and Laughlin on November 19, 1946, which operates a low volatile coal mine near Mullens, Wyoming County, West Virginia; and Darr Smokeless Coal Company, a West Virginia corporation acquired by Jones and Laughlin on March 17, 1948, which operates a low volatile coal mine at Twin Branch, McDowell County, West Virginia.

The officials of Jones and Laughlin Steel Corporation believe that substantial economies will be effected through the elimination of these three subsidiaries.

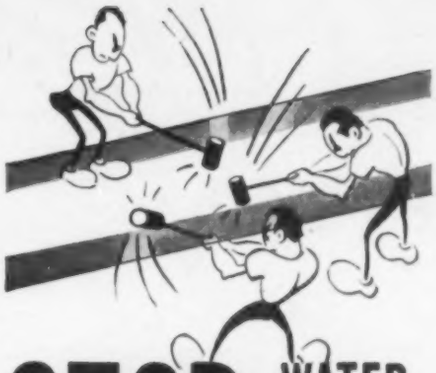
ALL-PURPOSE FITTING HAS IMPROVED DESIGN

▲ Lincoln Engineering Company, manufacturers of a complete line of lubricating equipment, announce that new, improved "Kleenseal" bullneck type grease fittings are now available in a wide range of sizes and styles. These grease fittings were originally developed by the Lincoln Engineering Company for the U.S. Army Ordnance Department. They incorporate the most desirable characteristics of former types of high-pressure fittings and permit standardization on one, all-purpose fitting. They represent the first major improvement in grease fitting design that does not obsolete couplers and grease guns in general use today — they can be securely contacted by all commercial hydraulic couplers.

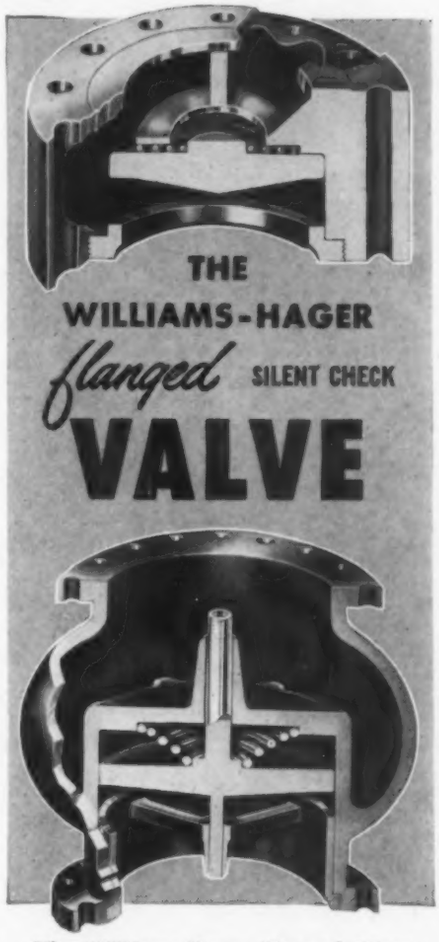
MULTIPORT VALVES HAVE NEW APPLICATION

▲ Experiments conducted over the past ten years using high pressure air supplies for blast furnaces are providing a new application for Cochrane multiport valves. The pressure and velocity at which air is admitted to the blast furnace are of utmost importance in order to avoid extraordinary loss of coke and lime from the top surface as dust.

The development work has been done by Republic Steel Corporation. From normal operation at top pressures of 2 psi and bottom pressure of 22 psi, utilizing 75,000 cfm of air,



STOP WATER HAMMER



THE WILLIAMS-HAGER *flanged* SILENT CHECK VALVE

The Williams-Hager Flanged Silent Check Valve is available for every service . . . bodies of Iron, Semi-Steel, Cast Steel, Government Bronze, Stainless Steel or Monel Metal . . . fitted with seats and discs of either Government Bronze, Stainless Steel or Monel. Standard sizes from 1 inch to 20 inches. *Write for new technical bulletin.*

THE WILLIAMS GAUGE CO.

Pump Valves . . . Water Gauges . . . Gauge Cocks . . . Steam Traps . . . Pump Governors . . . Feed Water Regulators . . . Water Columns

3076 PENNSYLVANIA AVE. · PITTSBURGH (12), PA.

Republic converted its Cleveland No. 5 blast furnace to take 113,000 cfm of air which required a bottom pressure of 30 psi and resulted in a top pressure of 12 psi. Velocity has thus been reduced from 65 to 50 feet per second and the contact time of the reducing gases with the ore has been increased from about 1½ to 2 seconds. Pig iron manufacturing costs are cut by more than a dollar per ton, coke consumption is reduced 12 per cent, and furnace capacity is increased 20 per cent with a simultaneous reduction of dust and increased pig iron quality.

Current development includes further increasing air supply to 125,000 cfm at 40 psi. This means 6900 tons of air a day — greater than the weight of iron ore, coke, and limestone used. Because uniformity of pressure is necessary to maintain velocity, the air line will be protected by a special 24-in. horizontal multiport relief valve fitted with a hydraulic cylinder and special control designed to relieve instantaneously at 40 psi. Springs alone will give slight instantaneous relief but to provide maximum opening immediately with little or no pressure rise hydraulic control will be used for the valve discs.

NEW STARTER PROTECTS HIGH VOLTAGE MOTORS

▲ For protecting high voltage motor circuits against damage from short circuits, Electric Controller and Manufacturing Company announces a new line of starters for use with 2300-4600 volt motors.

Known as "Valimitor" (volt-ampere-limitor) motor starters, they are designed for use, with safety, at any point on any power system regardless of the available kva. The bus may have infinite capacity. The starter and motor may be connected out on the end of the line or right onto the generator bus.

These new starters limit the maximum fault current that can be obtained on any system to approximately 25,000 kva, which is easily interrupted by the magnetic contactor used in these starters. The interrupting capacity rating is actually 50,000 kva, and under a maximum fault condition, the electromagnetic forces

The new motor starter is a self-contained unit for use with 2300-4600 volt motors.

set up in the starter will be only one fourth of this rating. All apparatus on the system back to the power source (including generators) is likewise subject to reduced stresses.

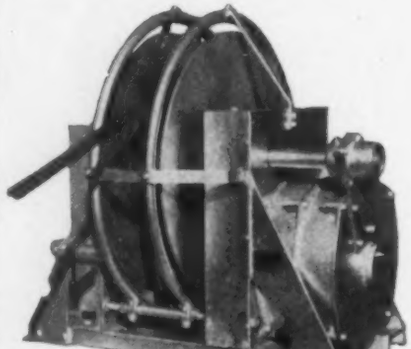
Because the new motor starter limits the maximum obtainable fault current to a value independent of the kva capacity of the power system, the installation remains permanent. There is nothing to change should power capacity be increased at a future date. There is nothing to replace when a fault occurs.

The motor starter is a self-contained unit. The upper half of the front cubicle contains the disconnect switches and "Valimitors." The magnetic overload relays are mounted in the lower half of this cubicle. When the starter is for use with synchronuos motor, the automatic field-switching panel for the synchronous motor field is also mounted in the lower part of the cubicle. The magnetic contactor for handling the main circuit of the squirrel-cage, synchronous or wound-rotor motor is mounted in the oil tank at the rear.

HUDSON MOTOR BEGINS SHEET STEEL PRODUCTION

▲ Production of steel sheets started April 16, 1948 in the plant of the Valley Manufacturing Company, a subsidiary of the Hudson Motor Car Company. One finishing mill went into operation, with five other finish-

A NEW LINE OF
EXTRA HEAVY DUTY
GLEASON CABLE REELS



SM SERIES

Spring Driven Geared Reel
For Electric Cables
125 Amps — 600 Volts
Continuous Contact
All Ball Bearings
Two-way Payout
Non-Revolving Springs
Fabricated Steel
Watertight
Replaceable Spring Motors
Adjustable Tension
8 Standard Sizes

These reels were developed to meet the unusually severe operating conditions found throughout the steel industry and are of exceedingly rugged construction.

The spring motors are interchangeable and removable so they may be replaced without handling loose springs. Replacement springs are supplied by the factory already installed in the housings and the replaced housings are returnable for credit.

The springs are wound on extra large hubs to minimize flexing at that point.

Adjustment of the spring torque is accomplished by means of a crank handle which is removable. A lock is provided to hold the drum in position during spring adjustment.

Improved current collector and brush rigging, with extra wide spacing, minimizes the possibility of electrical troubles.

J. L. GLEASON & CO., Inc., 209 Bent St., Cambridge, Mass.

ing and two roughing mills to be ready within a short time. Due to the shortage of sheet bars, skelp is being rolled in pairs for the time being.

Early in January, when the company took over the plant once occupied by the Shenango tin plate mill, it was announced sheet production would start in 100 working days.

Under the works managership of John C. Griffin, and with Frank Oppenheimer as general superintendent, the Valley Manufacturing Company is now operating at full rate.

FORK TRUCK HAS ENCLOSED CAB

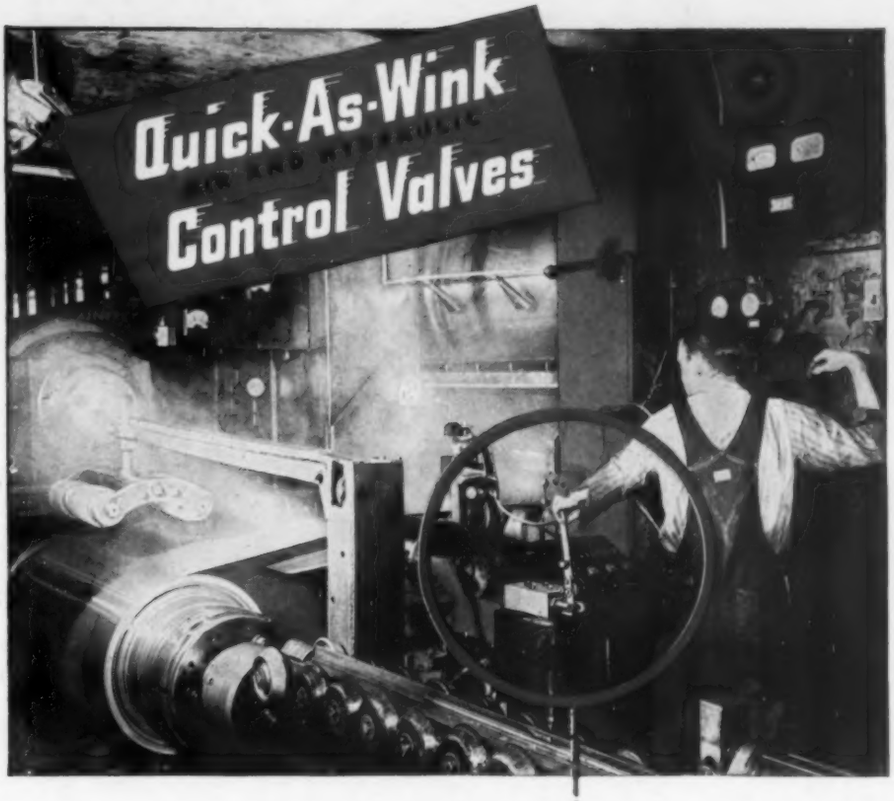
▲ A welded steel, sound-insulated, all-weather cab for use on the Clark "Yardlift-40," pneumatic-tired fork truck was announced by the Tructractor Division of Clark Equipment Company. The cab is fully enclosed, with entrance door on the driver side. It is equipped with sliding windows, safety glass throughout, and an upper

The cab is fully enclosed, with entrance door on the driver side.

window of glare-proof glass to aid high stacking. The interior is finished with a sound-deadening, insulating compound. Rearview mirror and windshield wiper are standard equipment; and a hot water heater is available as extra. The cab is easily mountable for field installation.

BLOOM ENGINEERING BUYS PAULSEN COMPANY

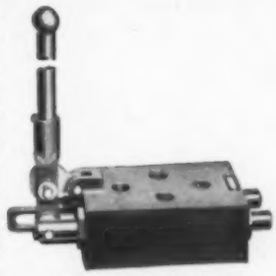
▲ Bloom Engineering Company, Inc., Pittsburgh, Pennsylvania, manufacturers of industrial and steel mill furnace burners, has purchased the Paulsen Engineering Company, Cleve-



For a maximum of long, efficient, trouble-free service

● Quick-As-Wink Valves are high quality controls designed and built to meet the most exacting requirements. All operating parts are in pressure balance eliminating any tendency to creep or crawl. The U-shaped packers are expanded by pressure and seal tightly preventing leakage. There is no lapping—no grinding—no metal-to-metal seating. Every valve is precision made and individually tested to its full pressure rating before being shipped.

Furnished in hand, foot, pilot, solenoid and diaphragm operated designs for controlling all types of air and hydraulic equipment. Let us work with you on your requirements!



Quick-As-Wink Lever Operated Hydraulic Valves

The HS-551-N4 pictured above is a neutral position 4-way valve for controlling double acting cylinders. It has a machined steel housing, chrome plated and polished stainless steel plungers, and renewable metal rings to take the impingement of the liquid flow preventing wear on the U-packers. Used for oil or water up to 3500 P.S.I. and 150° F. Other valves available for pressures up to 5000 P.S.I.;—but send for a catalog today and get *full* details about the *complete* line.

Quick-As-Wink Control Valves

THE HIGHER THE PRESSURE • THE TIGHTER THE SEAL

Manufactured by **C. B. HUNT & SON, Inc.,** *Salem, Ohio.*

Engineering and Sales Representatives in the Principal Cities

Only new *PROTECTO-WELD* design gives you *all three magnet features*

Investment in a welded lifting magnet, to be sound, ought to satisfy three vital requirements. They apply equally to all types of operation, whether steel mill, scrap yard, railroad or fabricating plant.

Is the magnet rugged enough for the roughest jobs? Ohio Protecto-Weld Magnets withstand hard knocks day in and out for years. Heavy-duty outer ring and top plate are welded together ON TOP OF THE MAGNET. Frequent blows against magnet side cannot crack or damage welded area. Magnet remains hermetically sealed against moisture indefinitely!

Does the magnet lift efficiently over extended periods of operation? Ohio Protecto-Weld Magnets use heavier-duty copper coils with non-cracking asphaltum insulation. They operate cooler, lift more uniformly for longer periods of operation.

Can the magnet be serviced, if necessary, quickly and economically? Since the weld on Ohio Protecto-Weld Magnets is ON TOP, it retains its shape, is never dented in. Thus, the weld can be turned down for disassembly without cutting away outer ring. Repairs are effected quickly, economically, without replacing outer pole.

Only Ohio Protecto-Weld Magnets give you *all three big advantages.* Sizes include 39, 55 and 65 inches diameter; 4, 6 or 8-coil construction. Write today for details to Ohio—*leader in magnetic materials handling.*

Ohio MAGNETS

also a leading name in the small motor field

THE OHIO ELECTRIC MFG. CO.

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land, Ohio, according to F. S. Bloom, president. Paulsen Engineering Company was engaged in the manufacture of blast furnace gas burners for stoves and boilers. Bloom Engineering Company will continue the design, manufacture, and application of these burners.

HAYS OPENS PLANT FOR PANEL BOARDS

▲ Devoted exclusively to the fabrication of panel boards for automatic combustion control and instruments and controllers used in process plants, a new manufacturing building was dedicated by Hays Corporation at ceremonies held recently at the Michigan City, Indiana, plant.

The addition was made necessary not only by the steady growth in the demand for Hays automatic combustion control but to make room for the newest addition to the list of Hays products — a line of electronic instruments for use in industry where super accuracy is demanded.

Additions and changes in the main plant were also completed recently to accommodate the increased office personnel made necessary by the increase in business.

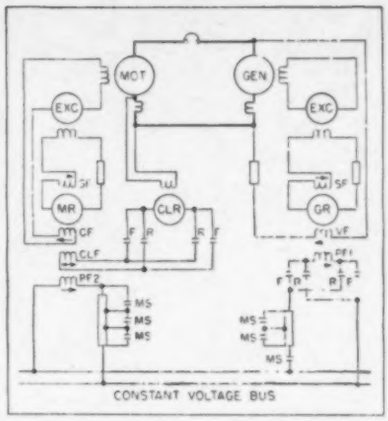
SOLVENT CLEANER FOR METAL CLEANING

▲ A new emulsifiable solvent cleaner that dilutes with water for efficient cleaning of metal parts in pressure spray-type washing machines, has recently been announced by Oakite Products, Inc.

Designed to solve difficult problems of large-scale production cleaning, Oakite Composition No. 97 forms water emulsions suitable for spray application in single or multi-stage metal washing machines for cleaning steel, brass, aluminum, zinc and other metals before electrocleaning or prepaint treatment or between processing operations. Extensive shop and factory tests on sheet metal and die castings have demonstrated, it is said, its ability to remove buffing compounds, drawing and stamping compounds, cutting and grinding compounds, mill and slushing oils, other rust-preventives, cutting and machining oils, metal chips and shop dirt.

Paramount among the reported

features of this new composition are: (1) its surface-active agents speedily penetrate and loosen deposits so that they readily flush away under the impact of cleaning and rinsing sprays; (2) at recommended concentrations it shows no tendency to foam; (3) since the emulsions do not hold soils in permanent suspension, their effective life is prolonged and nozzle-clogging reduced; (4) a temporary rust-retarding film remains on work; (5) added to rinse water in small quantities, material minimizes water-spotting; (6) the water emulsions present no fire hazards and do not give off toxic vapors; (7) solid-particle dirts are effectively removed.



This control scheme requires individual exciters for motors and generator fields.

CONTROL INCREASES PRODUCTION 20 PER CENT

By E. FRISCH

WESTINGHOUSE ELECTRIC CORPORATION

▲ To meet the record demand for steel it has frequently been found more economical to increase the production of older electrically driven mills by modernizing the available control equipment than to purchase new mill equipment.

Production of reversing blooming mills can be increased by two different methods:

1. Reducing the time required for handling the ingots between passes.
2. Increasing the rate of mill motor acceleration and deceleration. This is especially effective during the early stages of a rolling schedule when a pass is completed before the mill reaches maximum speed.

The handling time may be reduced by improved control of the entry and delivery table drives, the screwdown drive, and the ingot manipulators, but by far the greatest increase in production can be realized by the second method. A recent modernizing of the latter type on a blooming mill that was electrified in 1921 raised the average mill production from 162 tons to 200 tons per hour, an increase of better than 20 per cent.

Power for blooming mill motors is supplied in a variable voltage system by d-c generators forming part of a motor-generator set and the speed is controlled by regulation of motor and generator excitation. Motor acceleration or deceleration is a function of the rate-of-change of the magnetic field flux and can be increased by providing high field forcing. On older mills generator and motor fields usually are energized from a constant voltage bus. This method permits only a limited amount of forcing and the rate of acceleration and deceleration is low.

A control scheme, as indicated in the simplified diagram, has been developed to increase the forcing. This scheme requires individual exciters for motor and generator fields with sufficient capacity to produce 400 per cent of the required maximum steady-state field voltage. Excitation for the exciters is supplied by two Westing-

PICTURE OF PROGRESS

Straight-line pickling of rod in RODINE-inhibited acid. RODINE makes available more rod for drawing—by protecting metal from acid attack.

CHEMICALS ACP PROCESSES
RUST PROOFING AND PAINT BONDING
Granodine ®
Durodine ®
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RUST REMOVING AND PREVENTING
Inocrodine ®
Ferrolene ®
PICKLING ACID INHIBITORS
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Rodine® MEANS EFFICIENT PICKLING

"RODINE" is your key to efficient and economical pickling. "RODINE" inhibited acid removes scale and rust—cleans large surface areas with minimum acid and metal loss.
The new era of pickling with "RODINE" has replaced needless waste with savings in acid and metal that more than pay for "RODINE".

Pioneering Research and Development Since 1914
AMERICAN CHEMICAL PAINT COMPANY
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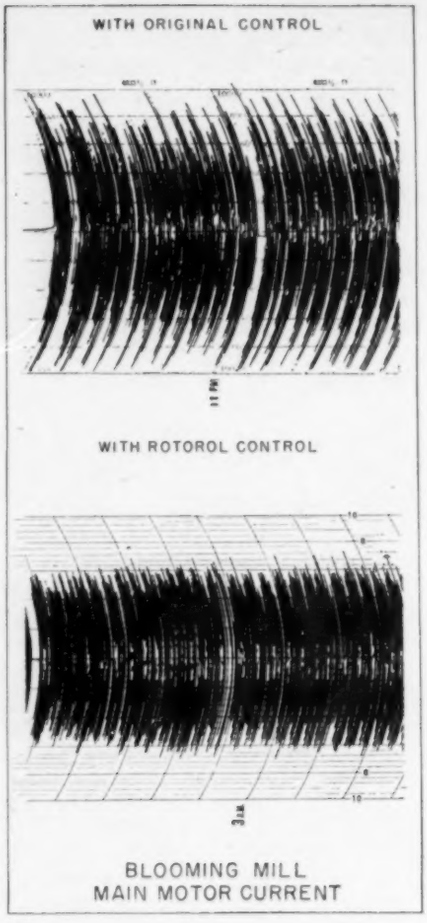
Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

house Rototrol regulators. The generator Rototrol functions as a voltage regulator which quickly raises or lowers the generator voltage in response to the movement of the master switch. This varies the current in Rototrol field PF1 and sets a pattern to which the generator voltage, as measured by field VF, is matched. The motor Rototrol serves to regulate the motor field current, as measured by field CF, to a value determined by the current in pattern field PF2 which is also controlled by the master switch.

A current limit Rototrol CLR is provided to prevent excessive motor currents resulting from rapid movement of the master switch or from not overloading. This Rototrol has specially designed pole pieces with magnetic shunts which causes its voltage to remain near zero until its field current, which is a measure of the motor current, reaches a predetermined value. For higher currents the voltage builds up rapidly and energizes motor Rototrol field CLF in a direction to reduce the motor current.



It is interesting to note that current peaks are materially reduced with this new control.

To obtain reversal in the shortest possible time and with the least shock to the equipment, when moving the master switch rapidly from full forward to full reverse position, the control functions in the following sequence. Several relays and contactors required to control this sequence are not shown.

1. The motor field current increases to a maximum while full generator voltage is maintained.
2. The generator voltage decreases to zero and builds up to a maximum in reverse direction while full motor excitation is maintained.
3. The motor field current decreases to the full speed value.

It is interesting to note that in spite of the much faster reversal time, the current peaks are materially reduced. On a mill powered by a 5800 hp, 600 volt, double armature motor the regenerative current peaks were reduced from 6000 to 4000 amperes and the motoring current peaks were reduced from 10,000 to 6500 amperes

BIGGER LOADS...MORE TRIPS
The Blaw-Knox line of Heavy-Duty, Four-Rope Buckets includes many specialized designs for fast rehandling of ore, coal, slag, etc.... Capacities up to 25 tons. From the array of buckets listed and illustrated in Catalog No. 2059 you will find the one that fills your requirements exactly. Send for a copy.
BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2040 Farmers Bank Bldg., Pittsburgh 22, Pa.
BLAW-KNOX BUCKETS

with an occasional 7500 amperes tap. This reduction in current peak has resulted in considerably less brush wear. Mechanical maintenance has also been reduced because of the smoother operation obtained through the cushioning effect of the Rototrols.

CARNEGIE-ILLINOIS HAS 22 PRODUCTION RECORDS

▲ Twenty-two steel production records during March were reported from six Pittsburgh-Youngstown district plants of Carnegie-Illinois Steel Corporation. The records, old and new:

Homestead district works: Total production for one month, exclusive of wheels and axles, 883,791 tons, old record 872,632 tons in October 1947; one-day record of 14,729 tons of open hearth ingots on March 31, old record 14,337 tons on October 16, 1947; one-day record for open hearth shop No. 5 6653 tons on March 31, old record 6526 tons on October 16, 1947; monthly record of 370,621 tons for all open hearth furnaces, old record 370,369 tons in October 1947.

Wheel and axle division, McKees Rocks, Pennsylvania: Monthly record for rolled wheels 25,045 pieces, old record 23,594 pieces in May 1947; monthly tonnage record for rolled wheels 8762 tons, old record 8247 in April 1947; forged axles 5737 tons, old record 5656 tons in October 1947; rolled wheels shipping record 26,207 pieces, old record 25,342 pieces in May 1947.

Duquesne works: New electric furnace record for third consecutive month 14,523 tons, old record 14,463 tons in February, 13,708 tons in January; best previous mark, 13,391 tons in November 1947.

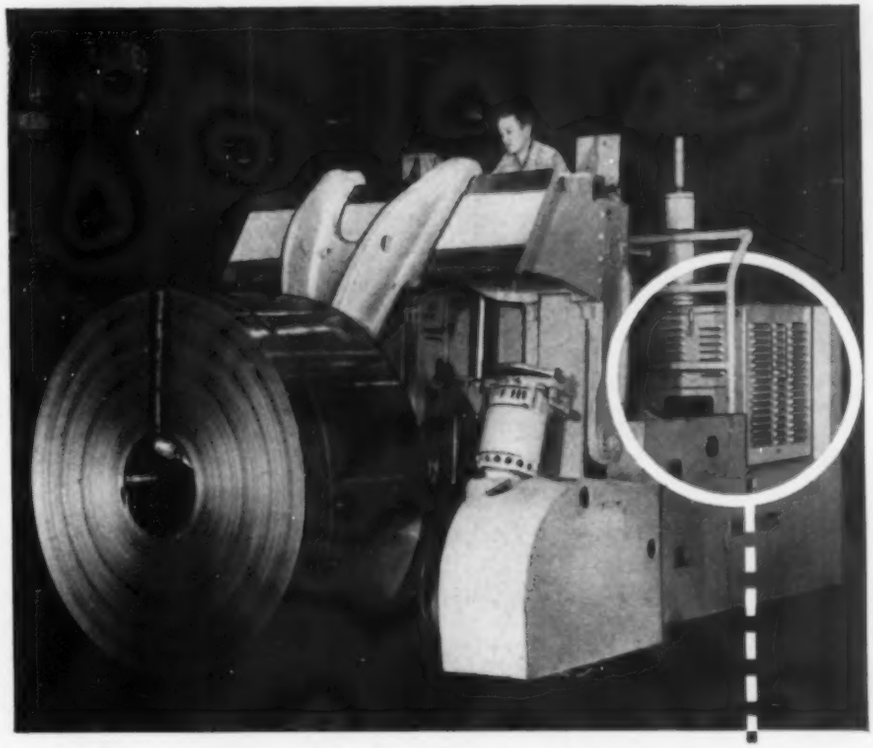
McDonald works, McDonald, Ohio: Total production for one month 198,029 tons, old record 197,934 tons in March 1944; 8-inch hoop mill 5240 tons, old record 3636 tons in June 1920; 10-in. bar mill 27,559 tons, old record 26,188 tons in January 1948; 43-in. mill 91,614 tons, old record 85,488 tons in January 1948; 43-in. mill shipping record 91,963 tons, old record 81,282 tons in January 1948.

Irvin works: Three stand cold reduction mill 44,770 tons, old record 41,814 tons in December 1947; No. 2 five-stand cold reduction mill 42,094 tons, old record 40,795 tons in August

constant power

FOR THE WORLD'S FASTEST STRIP MILL

Weirton Steel Works, Weirton, W. Va.

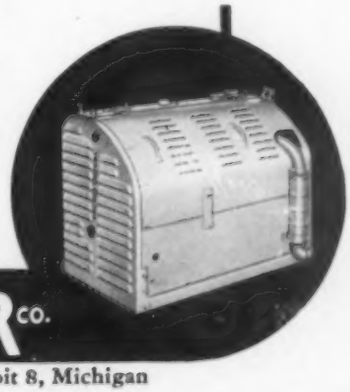


constant power

WITH READY-POWER-EQUIPPED ELECTRIC TRUCKS

Illustrated at top is one of two 2250 HP Motors at the Weirton Steel Works, Weirton, W.Va. furnishing *constant power* to drive the finishing rolls of the world's fastest cold-reduction strip mill capable of mile-a-minute production.

Equally constant and dependable is the power provided by the Ready-Power gas-electric unit on the "Automatic Skylift Giant" electric truck shown carrying one of the mill's 30,000 lb. rolls of finished strip. For electric trucks of any make or type, new or old, where constant power for hour-after-hour operation is needed—specify Ready-Power.



THE READY-POWER CO.

3836 Grand River Ave., Detroit 8, Michigan

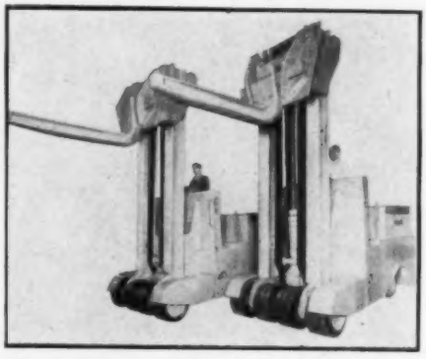
1946; total production five-stand cold reduction mills 69,329 tons, old record 68,918 tons in October 1947; electrolytic tinning on a single line 206,039 base boxes, old record 192,508 base boxes in October 1947; electrolytic tinning three lines 558,456 base boxes, old record 535,257 base boxes in October 1947; sheet mill shipments 108,396 tons, old record 106,352 tons in December 1943; total plant shipments for one month 165,470 tons, old record 158,122 tons in December 1947.

Vandergrift, Pennsylvania plant: Blooming mill 37,814 tons, old record 32,119 tons in August 1944.

YALE AND TOWNE BUILDS 20-TON RAM-TYPE TRUCK

▲ The ever-increasing size of strip-coils handled by the nation's overworked steel mills, and the necessity of cutting present high production costs throughout the metal-producing industry, make significant the new 20-ton ram-type electric power truck recently announced by the material handling division of Yale and Towne Manufacturing Company. The new truck was designed to improve coil-handling during processing, storage, and shipping operations. Specifically, it has an elevating height of 10½ ft, a lifting capacity of 20-tons, a maximum speed under load of 5 miles per hour, a 360 degree rotating drive unit which permits operation in narrow (10-ft wide) aisles, and unobstructed driver visibility.

The two K41 trucks shown are to be used by Republic Steel Corporation (Strip Mill No. 98) in Cleveland, Ohio. They are designed so the operator can see clearly, without leaving his post, all loading, transporting, and tiering operations. The 10½ ft lifting height permits double stacking of coils ranging up to 72 in. in diameter. Truck balance is arranged so that perfect stability is maintained under a 50 per cent overload, overloading being common in the steel industry. In addition to the 360 degree rotating drive unit which allows for operation in narrow aisles, a minimum steering radius of 12 ft permits the truck to be turned away from the face of stacked coils within an aisle only 8 in. wider than the overall length of the truck. (The Republic Steel trucks are 225 in. long, including the ram.) Savings in strip mill floor space is the benefit.



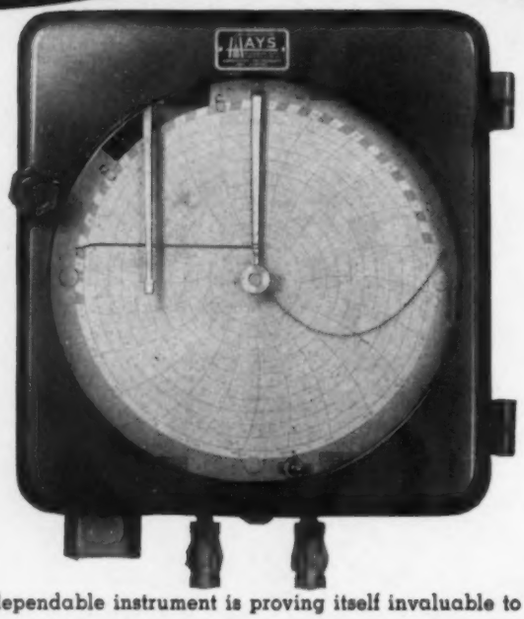
These trucks are designed so the operator can see clearly all loading, transporting, and tiering operations.

Rated truck capacity is 25,000 lb with a load 92 in. long, 40,000 lb with a load 42 in. long. The total weight of the truck is 6500 lb.

The tire arrangement is such that no overloading on the rubber is possible; and each of the two forward pairs of wheels are articulated to accommodate the irregularities of mill flooring and to prevent throwing the entire weight of the truck on any tire

A Practical Means TO CLOSER QUALITY CONTROL

The HAYS "OT" Pressure Recorder



THIS dependable instrument is proving itself invaluable to the steel industry . . for maintaining proper atmospheres in soaking units, annealing furnaces, open hearth furnaces, slab mills, and any place where an accurate record of draft, pressure or differentials is required.

You get an errorless record of two draft values, two pressure values, two differential values, or any combination of two of those values.

A good many new and modernized open hearth installations are equipped with Hays Series "OT" Pressure Recorders . . . as a simple, dependable, practical means to closer quality control.

Step 1 toward getting the benefits of this modern quality control is to get the facts about it. Bulletin 43-586 tells them . . . better send for it.

THE HAYS CORPORATION
SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

which encounters a sizeable obstacle.

Typical usages will be: (1) moving coils from the strip mills to storage, (2) tiering the coils in storage, (3) handling intra-plant shipments, (4) charging annealing furnaces, and (5) loading carriers.

KOPPERS TO BUILD 51 COKE OVENS IN CHICAGO

▲ Peoples Gas Light and Coke Company, Chicago, Illinois, has awarded a contract for the erection of a battery of 51 by-product underjet coke ovens at its Crawford Avenue plant to Koppers Company, Inc. The additional ovens, to be built at a cost in excess of $3,500,000 will increase the present carbonizing capacity by approximately 40 per cent.

The ovens to be built are unique in that they will be constructed so that natural gas, producer gas, propane gas, butane gas, or coke oven gas can be used to heat them. Originally, natural gas will be used.

The contract awarded by Peoples provides that the ovens will be of the latest Koppers-Becker underjet type, with self-sealing doors and modern oven machinery.

Gas from the Peoples Gas Light and Coke Company ovens is mixed with natural gas for domestic and industrial use. Coke made there is sold domestically and to industry, and also is used in the production of water gas.

Actual construction of the new battery of ovens will be started at once, and work will be pushed so that the ovens may be put into operation by March 1, 1949. The new battery will be capable of carbonizing approximately 1000 tons of coal every 24 hours.

BABCOCK AND WILCOX BUILDS X-RAY BUILDING

▲ A building specially designed to house the two million volt x-ray machine recently installed by Babcock and Wilcox Company to examine the welds in high-pressure, high-temperature boiler drums manufactured at its Barberton, Ohio, works, has just been completed. Simultaneous with the opening of the new building, the company announces operation results with the new machine, which is the first of its size to be used exclusively for the testing of welds in pressure vessels.

With the new machine, which has been in operation for several months, production of large pressure vessels and boiler drums has been speeded up considerably because of the much shorter exposure time now required in x-raying pressure vessels 4½ to 6½ in. thick. Otis R. Carpenter of the works laboratory stated that small laminations which have not been seen heretofore on radiographs of heavy plate are more easily found, and a sensitivity to variations of under two per cent of the weld thickness is obtained. He characterized the results with the new machine as "very good."

The 70 by 30 ft building in which the machine is housed was designed to provide complete protection against x-rays and at the same time to give full freedom of movement in examining the largest pressure vessels built by Babcock and Wilcox Company. The building will accommodate drums up to 13 ft in diameter and 70 ft in length. A radiation check of the room

For the Utmost in Turbine Pump UTILITY AND CAPACITY

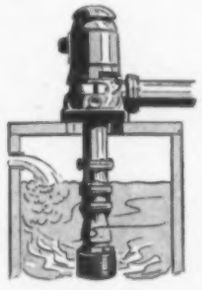
PEERLESS Vertical Turbine PUMPS

PEERLESS Builds a Pump to Suit Your Service—Capacities: 15 to 30,000 G.P.M.

PEERLESS VERTICAL TURBINE PUMPS FOR DEEP WELL SERVICE

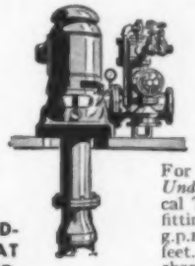
For development of a reliable, permanent water supply, install these deep well pumps with the type of drive most suitable to your application. You have a choice of electric, right angle gear drive, or belted (V- or flat) heads as well as the option of oil or water lubrication. Capacities from 15 to 30,000 g.p.m. are obtained from depths of 1000 feet or more. *Fully described in Peerless Bulletin B-141-1.*

PEERLESS CLOSE-COUPLED TYPE VERTICAL TURBINE PUMPS



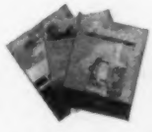
For pumping from short settings such as pits, sumps and surface water sources, such as lakes, rivers and ponds, get the full utility and capacity of a deep well pump with a close-coupled Peerless Vertical Turbine Pump. Makes an extremely compact installation. Uses include cooling tower service, boosting, recirculation and dewatering. Capacities: up to 30,000 g.p.m. *Fully described in Bulletin B-159.*

PLAN YOUR PUMP REQUIREMENTS WITH PEERLESS— *PEOPLE WHO CARE*



PEERLESS VERTICAL TURBINE APPROVED FIRE PUMPS...

For adequate fire protection, the *Underwriters' approved* Peerless Vertical Turbine Fire Pump, with proper fittings, produces from 500 to 2000 g.p.m. against heads from 240 to 285 feet. Built for instant operation. Discharge piping is simplified. Choice of drives and oil or water lubrication. *Fully described in Bulletin B-152.*



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PEERLESS PUMP DIVISION

Food Machinery Corporation

Factories: Los Angeles 31, Calif.; Quincy, Ill.; Indianapolis, Ind. *District Offices:* New York 5, 37 Wall Street; Chicago 40, 4554 North Broadway; Atlanta Office: Rutland Building, Decatur, Georgia; Dallas 1, Texas; Fresno, Calif.; Los Angeles 31, Calif.

fmc PEERLESS PUMPS

★ ★

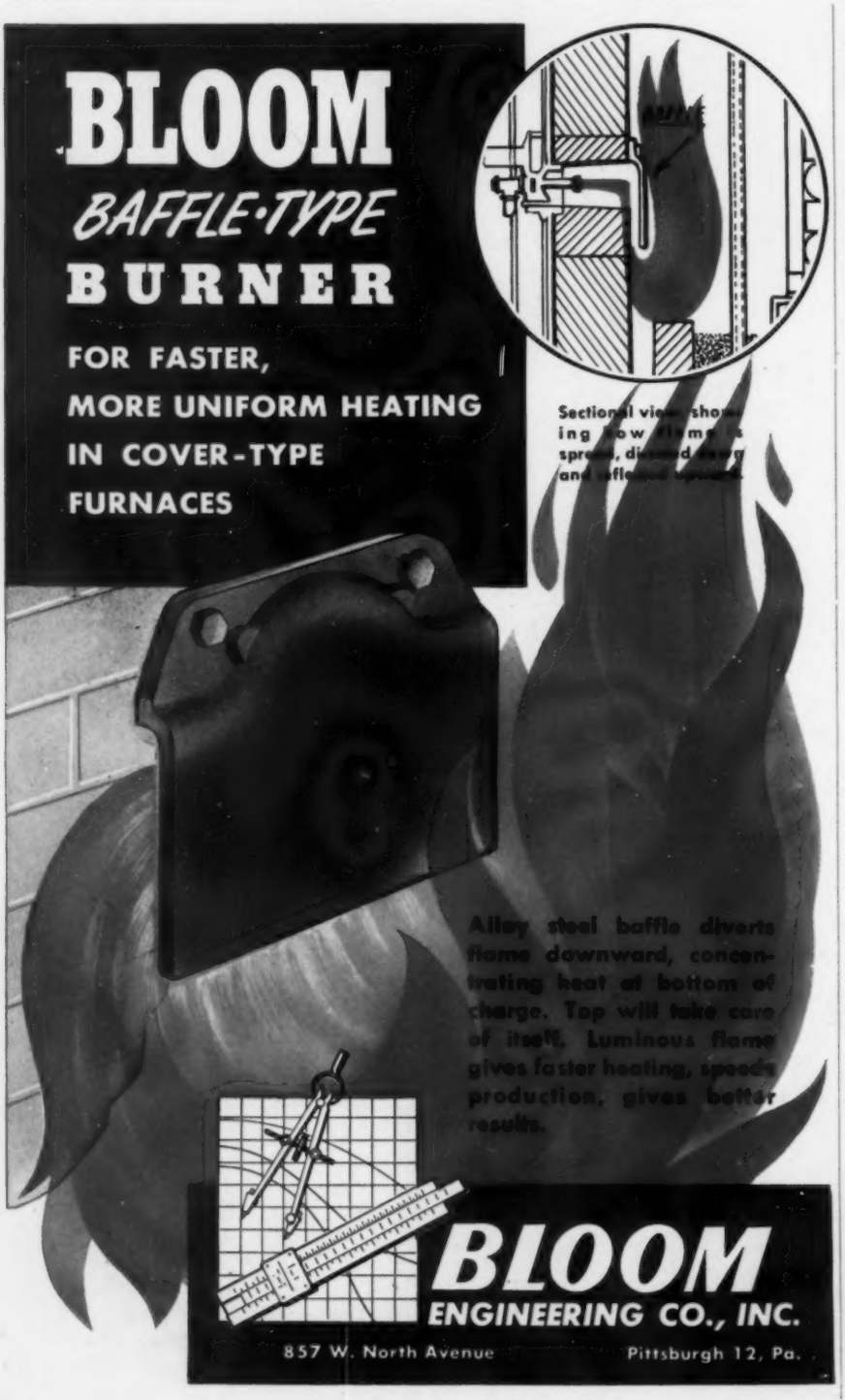
and its vicinity shows no radiation leakage at any point.

The walls are of concrete with a maximum thickness of 40 in., decreasing to 9 in. thickness toward the top of the 32 ft room. Access to the control room, which is an extension on one side of the building, is through a concrete maze with walls 40 in. thick.

Pressure vessels to be tested enter the building on power driven drum turners from the drum shop with which the new building is directly connected. The 120 ton x-ray room door moves horizontally on an overhead track and the floor along the doorway is raised to fit into an upward curve in the bottom of the door so that no x-rays can pass under the door when it is closed. A safety switch within the control room makes it possible to halt operations in case a workman finds himself in the room at the time testing is to begin.

The transformer and tube of the x-ray machine are contained in a large tank which is mounted on trunnions. An overhead floor-operated crane makes it possible to move the 6000 lb machine easily to any desired location.

Techniques in using the two million volt machine, which was purchased from the General Electric X-Ray Corporation are similar to those used in operating its one million volt predecessor at Barberton, Mr. Carpenter said. The new machine permits economical use of finer-grained, more sensitive films. It also makes possible a longer target to film distance. This has the double advantage of improving detail in the radiograph and allowing a greater length of weld to be x-rayed at one "set-up" without loss of density and contrast at the film ends. Exposure time for 5½ in. plate is 6 min when using a film distance of 6 ft.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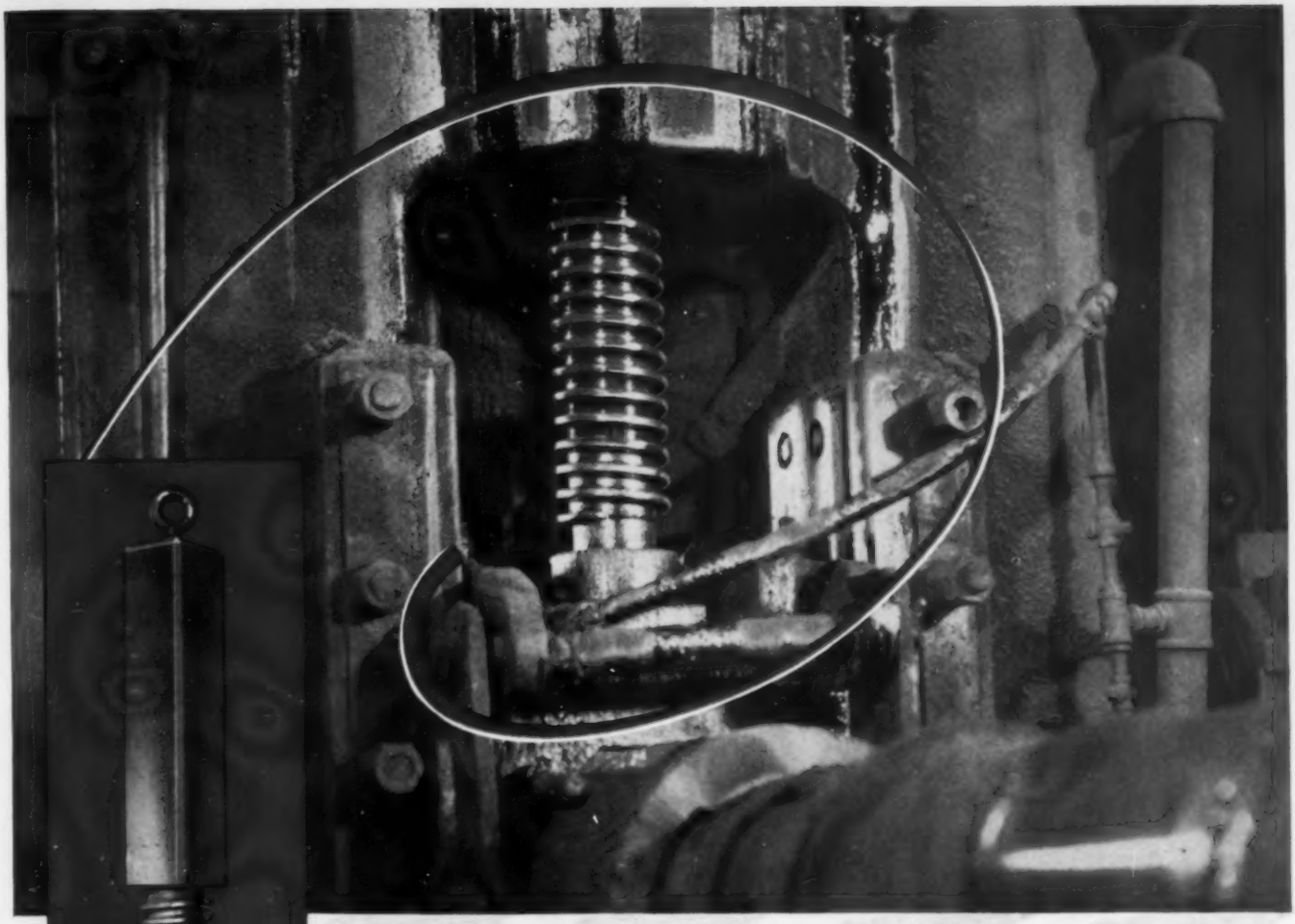
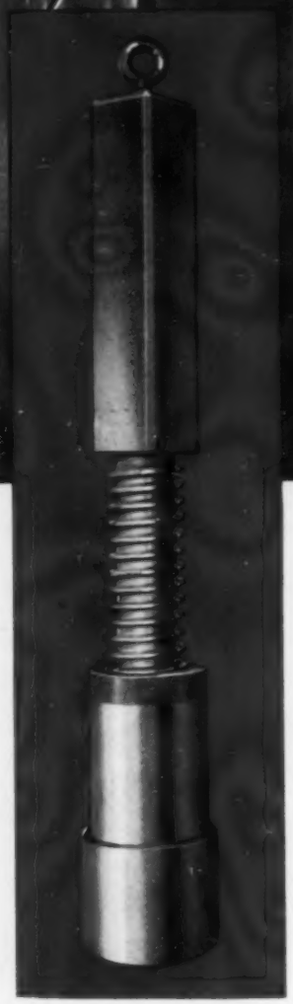
BAFFLE-TYPE
BURNER
FOR FASTER,
MORE UNIFORM HEATING
IN COVER-TYPE
FURNACES
Alloy steel baffle diverts flame downward, concentrating heat at bottom of charge. Top will take care of itself. Luminous flame gives faster heating, speeds production, gives better results.
BLOOM
ENGINEERING CO., INC.
857 W. North Avenue
Pittsburgh 12, Pa.

RECORDING SYSTEM EMPLOYS PLASTIC PANELS

▲ A new recording system has been developed by Applied Research Laboratories which is being applied to their direct-reading instrument for spectrochemical analysis, the "Quantometer" to greatly extend its range of application. The system which employs removable plastic panels fitted with direct-reading scales for each element being determined, allows panels to be made up for each type of alloy. With this arrangement the instrument can be set up for the analysis of any alloy of a certain base metal in a few minutes. This allows a producer of aluminum alloys, for instance, to analyze samples in the order received in three or four minutes, irrespective of the fact that one may be 75S with relatively high zinc,

This new unit uses removable plastic panels fitted with direct-reading scales.





"TOOL-STEEL" PROCESS SCREW DOWN SCREWS AND NUTS SLASH TONNAGE COSTS!

***Compare* these typical results:**

BLOOMING MILL		TONNAGE	SERVICE LIFE RATIO
40"	"TOOL STEEL" SCREWS	4,453,395	12 to 1
	CARBON STEEL SCREWS	371,892	
36"	"TOOL STEEL" SCREWS	3,495,515	3½ to 1
	TORCH HARDENED SCREWS	985,055	
32"	"TOOL STEEL" SCREWS	5,327,581	13⅓ to 1
	CARBON STEEL SCREWS	400,000	
40"	"TOOL STEEL" SCREWS (World's Record)	7,257,400	9⅓ to 1
	CARBON STEEL SCREWS	783,741	

"Tool Steel's" tonnage superiority has likewise been proved on plate and slabbing mills!

Greatly increase your tonnage through minimized "down-time"—investigate these cost-saving facts today!

"TOOL STEEL" PROCESS

The Standard of Quality

for GEARS • PINIONS • ROLLS • SPROCKETS • WHEELS *and other* HARDENED PRODUCTS

THE TOOL STEEL GEAR & PINION CO.

CINCINNATI 16, OHIO

the next 24S with considerable copper and the next relatively pure aluminum. The change of scales is necessitated by the fact that the high zinc and copper contents affect the determination of the eight or ten other elements being determined by small amounts. This device automatically corrects for these effects and thus allows the utmost in accuracy on a speed analysis basis.

EACH TON OF PIG IRON REQUIRES 4½ TONS OF AIR

▲ Air ranks with ore, fuel, flux and water as an important material in iron and steel making, the American Iron and Steel Institute pointed out. But because it is available in inexhaustible quantities, and because there is no invoice rendered for a given number of tons at a specific price, it is commonly overlooked in a discussion of the materials of steelmaking.

Without air, combustion could not be supported and blast furnaces, open hearth furnaces and bessemer converters would be useless.

For every ton of pig iron made in a blast furnace about 4½ tons of air are required. The solid raw materials entering the furnace add up to only 3¼ tons for each ton of hot metal produced.

A little more than 23 per cent by weight of the air which enters the blast furnace is oxygen, the element which supports life and combustion.

For each ton of steel produced in an open hearth furnace with a conventional charge of 60 per cent hot metal and 40 per cent scrap, about 100 pounds of oxygen or 435 pounds of air are required to promote chemical reactions.

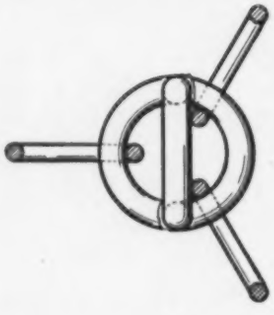
In a 25-ton bessemer blow, 7350 pounds of oxygen or 32,000 pounds of air are required to oxidize or burn out 2135 pounds of carbon, 620 pounds of silicon and 195 pounds of manganese.

PORTABLE CHARGER ELIMINATES GUESSWORK

▲ A new line of small, light, portable battery chargers is being introduced by Richardson-Allen Corporation. Each unit features a meter which can be read while the battery is being charged, thus eliminating guesswork as to battery condition. Circuit breakers prevent the nuisance of blown fuses resulting from crossed wires. Models are available rated from 6 to 80 amperes for average to fast charging. The chargers offer the ruggedness and dependability of full

Each unit features a meter which can be read while battery is being charged.

LONG LIVED
Frictionless
Magnet Suspension Chains



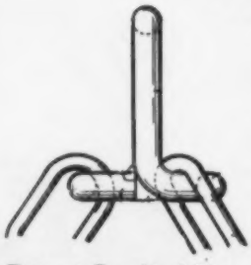
Suspension Chains for 55" and 65" Lifting Magnets that eliminate friction, so will last 4 times as long as old-fashioned Suspensions because:

1st: Each leg hangs free on ring and in magnet ears with no twisting or rubbing.

2nd: Suspension is made of high alloy steel — heat-treated:

3rd: Each 55" Suspension is tested to 85,000 pounds; each 65" Suspension is tested to 115,000 pounds.

Prompt shipment from stock.



Patent Applied For

DOWNTOWN COMPANY
1836 Euclid Avenue CLEVELAND 15, OHIO

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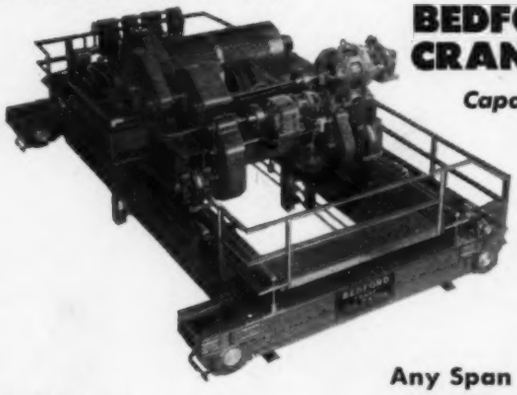

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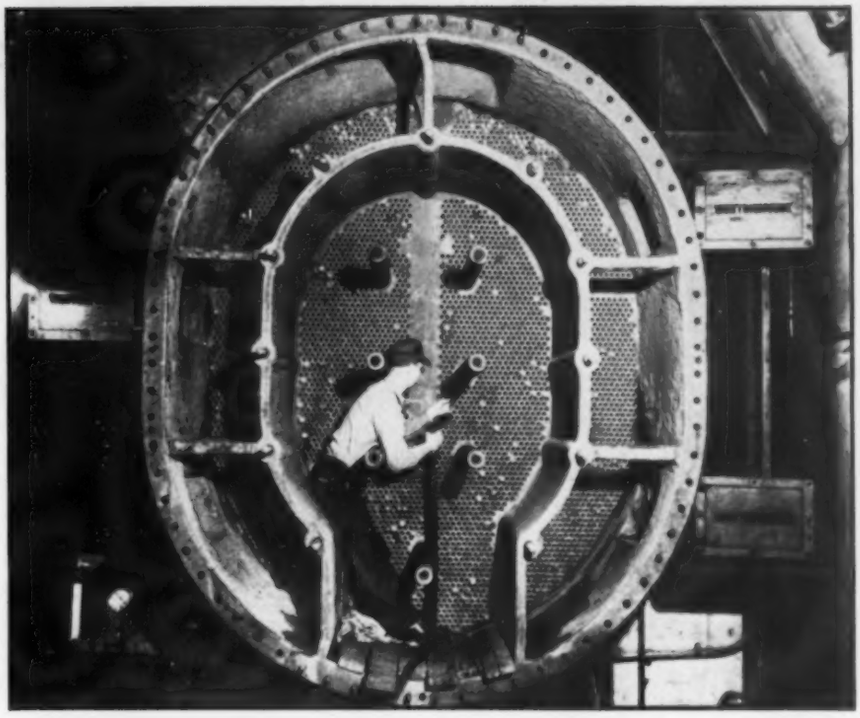
wave selenium rectification and the lighter weight of selenium plates makes them easily portable. The units plug into normal 110 volts, 50 to 70 cycle a-c current and are extremely economical on current usage.

INDUSTRIAL BRUSHES FOR TUBE CLEANING

▲ The most effective method yet found for cleaning the tubes of steam condensers is an entirely new brushing technique developed by the West Penn Power Company of Pittsburgh, and which has been tested under varying conditions for a period of over two years.

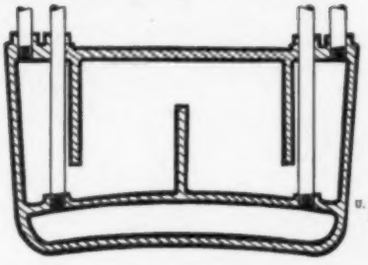
The new method not only decreases down or outage time required for this necessary cleaning operation; it also results in prolonged tube life, by eliminating the scratching and roughening of the interior tube surfaces caused by the former cleaning methods.

The new method of cleaning the steam condensers in service in the West Penn System involves the use of specially-designed nylon brushes,



Cleaning the 5681 tubes in one of the steam condensers at a power station by means of brushes takes approximately two eight-hour shifts by two men. Considerable reduction in equipment outage is obtained since using the brush method, as the effect of the thorough brush cleaning is more "lasting."

A QUICK LOOK
At the Advantages of the
DOBSCHA DOUBLE COMPARTMENT COOLING PLATE



U. S. PAT. NO. 2,311,819.

A GLANCE at the accompanying illustration will reveal the two prime advantages of the Dobscha Cooling Plate:

1 The "NOSE" compartment may be sealed off, in event of "burning," without reducing the cooling area of the large volume "BUTT" compartment.

2 Direct feed and discharge affords high velocity water travel through the nose, eliminating clogging due to bad water sediment.

Get THESE "PLUS VALUES" WITH THE DOBSCHA FROM FALCON

● Falcon casts the Dobscha Plate vertically, without anchors or chaplets, "NOSE" down, so the densest metal is in the "NOSE" where needed.

Falcon installs the copper "Feed" and "Discharge" pipes in the nose compartment.

Falcon ships each Dobscha Plate in a special crate or cradle which protects these nose "Feed" and "Discharge" pipes in shipping and handling between the foundry and your furnace wall.

Falcon is licensed to make and sell the Dobscha Plate. U. S. Pat. 2,311,819.

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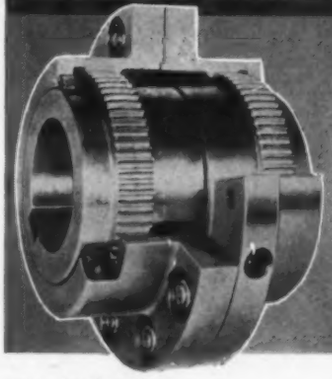
FALCON BRONZE CO.
YOUNGSTOWN 3, OHIO
Established 1890 • Incorporated 1895

Maybe you too, can switch to SMALLER DIAMETER COUPLINGS



SEE THE NEW "Series A" WALDRON COUPLING

Write for Copy of This Catalog 57

Its larger maximum bore permits use of smaller sizes for greater accuracy and economy. Requires less shaft extension. Provides neater, more compact job and retains all Waldron design refinements. Available in all popular types.

COUPLING DIVISION

JOHN WALDRON CORP.
Main Office and Works
New Brunswick, New Jersey
COUPLINGS

made by the Osborn Manufacturing Company, approximately four in. in length and ranging from three-fourths of an in. to one in. in diameter, depending upon the inside diameter of the tubes. A special cone-shaped steel washer, slightly smaller than the inside diameter of the tube, is welded to the wire stem at the trailing or pushing end of the brush. The brush is placed in the end of one of the 18 to 24-ft copper alloy tubes, and then "shot" through the tube by water at 200 lb pressure delivered by a specially-constructed nozzle-like "gun."

The brushing method not only rids the tube of mud and slime, the bane of most power plant engineers' existence, but it also brushes off and washes out all the algae so that a thorough cleaning job is done, and no algae spores are left to help collect further deposits.

The records indicate that since these special brushes have been used, condenser cleaning periods have been much further apart. This results in considerable savings because of the fewer equipment outages, and also because of the longer periods before sufficient new deposits accumulate to seriously affect the heat transfer of the condensers.

Cleaning an ordinary-sized condenser, containing from 6000 to 9000 tubes, is generally completed in two 8-hr shifts. In view of the limited space in which the cleaning men must work, it is usually not practical to use more than two men for the operation, one to plug the brushes into the tubes and the other to follow up with the water gun. A third man sometimes attends the two cleaners and returns the brushes for continued shooting.

Prior to the development of the brushing method, West Penn tried both metal and rubber plugs, and also most of the other practiced methods, to clean their condensers. The metal plugs proved more effective than rubber plugs, which seemed to compact the mud and deposits, making the use of scraper plugs mandatory. However, scratches and roughening by the metal plugs gave algae additional places in which to grow.

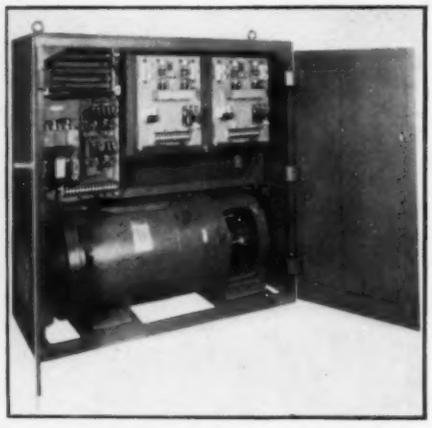
West Penn's six steam condensers at its Springdale, Pennsylvania, station take an average of 650 million gallons of raw water daily from the Allegheny River. There are also six condensers at the older Connellsville station and several at other smaller stations. Reducing condenser outage time is highly important at this period because of the greatly increased demands for power in the area served by the West Penn Company.

ELECTRONIC DEVICE FOR SPEED SYNCHRONIZING

▲ An electronic device designed primarily for synchronizing the speed of independently driven machines used in paper finishing, textile finishing, rubber extrusion, wire drawing and rolling and similar continuous process operations, is a recent development of engineers of Reliance Electric and Engineering Company.

Termed the "VSS" — or short stroke dancer roll control system — the unit represents a decided advance in controlling motor speeds from the position of the material passing between two machines where there is a short amount of motion to provide this control, and/or where the load of the controller must of necessity be very small. It is designed to eliminate the mechanical wear associated with sliding controls of the ordinary rheostat.

The device is essentially a phase shift rectifier capable of producing a variable rectified d-c output voltage. This is accomplished by displacing an iron core in a solenoid or wound coil. The unit has been designed for 230 volt d-c service and a maximum current of 2.0 amperes.



This short stroke dancer roll control system is a decided advance in motor control.

A special variable reactor and phase shift circuit was developed to surmount the customary objections of non-linear action and heavy magnetic pull. An open or air core reactor with two coils was used to reduce this magnetic pull on the movable plunger of the reactor.

Having mainly an air core, the intensity of the magnetic field is reduced and, therefore, does not exert so great a force on the iron core of the movable plunger. Also having two coils and moving the plunger out of one into the other tends to equalize the pull of each magnetic circuit.

Reactor coils are mounted in a bronze casting, which provides the top bearing for the plunger shaft. The bottom plate forms a suitable mounting arrangement as well as the bottom bearing. Average force needed to move the plunger is the friction of its shaft in the bearings. This is approximately one ounce in the horizontal position. Total movement of plunger is $\frac{9}{16}$ in.

ARMCO BECOMES OFFICIAL FIRM NAME

▲ The name of The American Rolling Mill Company was officially changed to "Armco Steel Corporation" at the annual meeting of stockholders, Charles R. Hook, president, announced. The change was effective April 17.

In expressing appreciation to shareholders for approving changing the company's name Mr. Hook said he was confident the action was in the best interest of the company and would prove a great convenience. "It is a clear cut example of the power of advertising," he declared. "Our trade name 'Armco' has been the theme of national consumer advertising since 1914, and has been emphasized in all publicity since then. The Armco trademark has been used on our products and on many of the products of our customers. As a result, our company for many years has been best known as Armco.

"In addition, the name 'Armco Steel Corporation' will more fully reflect the true nature and scope of our company's business," Mr. Hook stated. "Although originally engaged principally in rolling sheets, in a few years our company's business changed and broadened. For many years it has been a fully integrated steel company engaged in the manufacture of pig iron and steel as well as rolling operations, and also in the fabrication of steel products."

(*Please turn to page 140*)

DATE LINE DIARY...

April 1

▲ According to the American Iron and Steel Institute, steel sales for 1947 hit a new record of 7.1 billion dollars. Profit per dollar was about 6.3 cents, and steel earnings last year were approximately $450,000,000. The 1947 showing, however, was based on a dollar volume of sales which was 131 per cent higher than the 1929 volume of business, indicating the effect of inflation and higher costs on the returns in the steel business.

April 2

▲ Henry J. Wallace, general sales manager of National Tube Company, warned today that the American steel industry will have no choice other than to further postpone meeting its domestic requirements if forced by the Marshall Plan to meet an increasing percentage of world demand for steel products.

▲ Ore carriers today received the go-ahead to leave lower lake ports for Lake Superior in the hope of getting past ice barriers and loading iron ore. This is approximately one week earlier than in 1947.

April 3

▲ Westinghouse Electric Corporation informed its employees that a third round of wage increases would only serve to start up the inflationary spiral again and for this reason could not now be justified.

April 4

▲ According to the American Iron and Steel Institute, the total combined assets of the steel industry are about $6,000,000,000.

April 5

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 84.4 per cent of capacity for the week beginning April 5, equivalent to 1,521,300 tons of steel ingots and castings, compared to 1,591,600 tons one week ago.

April 7

▲ Production of railway freight cars in March was 9302 or about 10 per cent greater than the previous month of February and more than three times that of March 1947.

April 8

▲ In the stock market today, the rail average made a new high for the past 18 months.

April 10

▲ According to the Bureau of the Census, Department of Commerce, bad debt losses of wholesalers increased by 76 per cent from 1946 to 1947.

April 11

▲ As of today, steel companies in the United States possess 944 open hearth furnaces, 29 bessemer converters and 217 electric furnaces. The total combined annual capacity is 94,233,460 tons of ingots and steel for castings or more than ever before in peacetime. The industry's ironmaking capacity in 239 blast furnaces is 67,438,930 net tons.

▲ United States Atomic Energy Commission announced today a three-point program to stimulate the discovery and production of domestic uranium by private competitive enterprise.

April 12

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 71.3 per cent of capacity for the week beginning April 12, equivalent to 1,285,200 tons of steel ingots and castings, compared to 1,521,300 tons one week ago.

▲ As the preparedness program goes into effect, this country may face an acute shortage of non-ferrous metals, and if procurement is stepped up substantially, troublesome shortages may appear in lead, copper and aluminum.

April 13

▲ Employment in iron and steel plants during February, 1948 reached a post war peak of 626,200 wage earners and salaried workers. The average hourly rate of pay for wage earners amounted to $1.551 and the average hourly rate for all employees amounted to $1.638.

April 14

▲ The per capita production of ingot steel and steel for castings in the United States was 1180 pounds compared with an average for the entire world of 148 pounds. Second highest per capita production was 1124 pounds in Belgium and Luxemburg.

April 15

▲ The Department of Commerce estimates that an increase in steel capacity of 10,000,000 tons would require the following raw materials: iron ore, 10,900,000 net tons; coke, 7,070,000 net tons; and pig iron, 6,890,000 net tons. They also estimated that the increase in capacity would require 1½ to 2 million tons of finished steel. The Department of Commerce uses a figure of $250 per ton for estimating construction costs.

April 17

▲ Preliminary results, in a study made recently by the Automotive and Aviation Parts Manufacturers' Association, indicate that wage-fringe payments are becoming an increasingly important factor, and in that industry cost an average of almost 7½ cents an hour above direct wages for every hour worked in 1947. Legally required payments such as old age and survivor's insurance, workmen's compensation and unemployment compensation added about 4.8 cents to make a total of over 12 cents per hour. According to some figures compiled by the United States Department of Commerce, these fringe payments have grown from 1.2 per cent of the nation's wage bill in 1929 to 4.8 per cent in 1946.

April 18

▲ It appears that the recent coal strike will cost the nation over a million tons of steel before the industry has fully recovered from the reduced production caused by the strike.

April 19

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 80.0 per cent of capacity for the week beginning April 19, equivalent to 1,442,000 tons of steel ingots and castings, compared to 1,285,200 tons one week ago.

April 20

▲ According to the F. W. Dodge Corporation, iron and steel manufacturers led in building contracts. Of the approximately $3,000,000,000 invested in plant expansion in the 37 states east of the Rocky Mountains since the end of World War II, iron and steel building contracts totaled $212,074,000.

April 22

▲ Benjamin F. Fairless, president of the United States Steel Corporation announced today that effective May 1, steel prices will be reduced for a wide variety of products. Price reduction in the corporation is estimated at about $25,000,000 a year. Also because of the reduction in prices, United States Steel Corporation has denied the United Steelworkers of America their demands for substantial wage increases, since such increases would require an increase in steel prices. On the other hand reduction in costs should be the most effective method to counteract inflation.

April 25

▲ More than $596,602,000 have been invested in new plants and equipment in Pennsylvania by 417 metal and metal products companies. The 26 basic iron and steel companies represent the largest expenditure of any individual group for a figure of $285,173,845. Second place goes to 29 manufacturers of electrical machinery, apparatus and parts for a sum of $56,058,942.

April 26

▲ The General Electric Company announced today their second major reduction of prices in 1948 for their products. This latest reduction consists of a flat 5 per cent, effective April 16, and covers lines in which the company does an annual business of $200,000,000. Products affected are fractional-horsepower motors, switchgear, conventional distribution transformers, lightning arresters, feeder regulators, cutouts, and power capacitors.

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 86.6 per cent of capacity for the week beginning April 26, equivalent to 1,560,900 tons of steel ingots and castings, compared to 1,442,000 tons one week ago.

▲ Twenty-three of the nation's leading iron and steel manufacturing firms with extensive mining interests have been urged to investigate the two new deposits of iron ore explored in the Adirondacks by the commissioner of the New York State Department of Commerce. These deposits are near Santa Clara in Franklin County. Modern scientific equipment was employed during two seasons of work in the field to prepare detailed magnetic maps of these two deposits. Mining in New York State has taken a renewed lease on life, especially in the iron, zinc, talc and titanium producing industries. A ton of iron from New York's Adirondacks costs upon arrival at Pittsburgh the same as a ton of iron from the famous Mesabi Range in Minnesota but New York's iron is of a much higher grade. The ore is chiefly magnetite which in pure form is composed of 68 per cent iron as compared with the 45-50 per cent now found in Mesabi Range ore. Operations in New York State are both open pit and underground.

April 27

▲ Earnings for the first quarter of 1948, before declaration of dividends, of the United States Steel Corporation were reported as $33,957,341, compared with $39,234,511 for the same period in 1947. The coal strike had no appreciable effect on the earnings statement for the first quarter and will be reflected in the second quarter.

April 28

▲ The Inland Steel Company reported today that 1947 was a record year. Net income was $29,888,558 or $6.10 per share of capital stock outstanding. Earnings for 1947 amounted to 9.49 per cent of net sales as compared with an average return of 10.35 per cent for the four-year period from 1936 through 1939. Net sales for the first quarter in 1948 amounted to $90,527,112 or an increase of about 29 per cent over the same period in 1947. Ingot production during the first quarter of 1948 averaged 107.3 per cent of rated ingot capacity.

▲ Frank Purnell, president of Youngstown Sheet and Tube Company, reported today that the recent coal strike cost the Youngstown Sheet and Tube Company 105,000 tons of steel ingots. In spite of the coal strike, the company's operations during the first quarter this year were at 101.2 per cent of capacity.

▲ The International Nickel Company reported today that new uses for nickel progresses steadily and that it is expected that the trend of consumption will continue to show an upward course. Sales of nickel in 1947 were 102,640 net tons, which is the highest of any peace-time year except 1937.

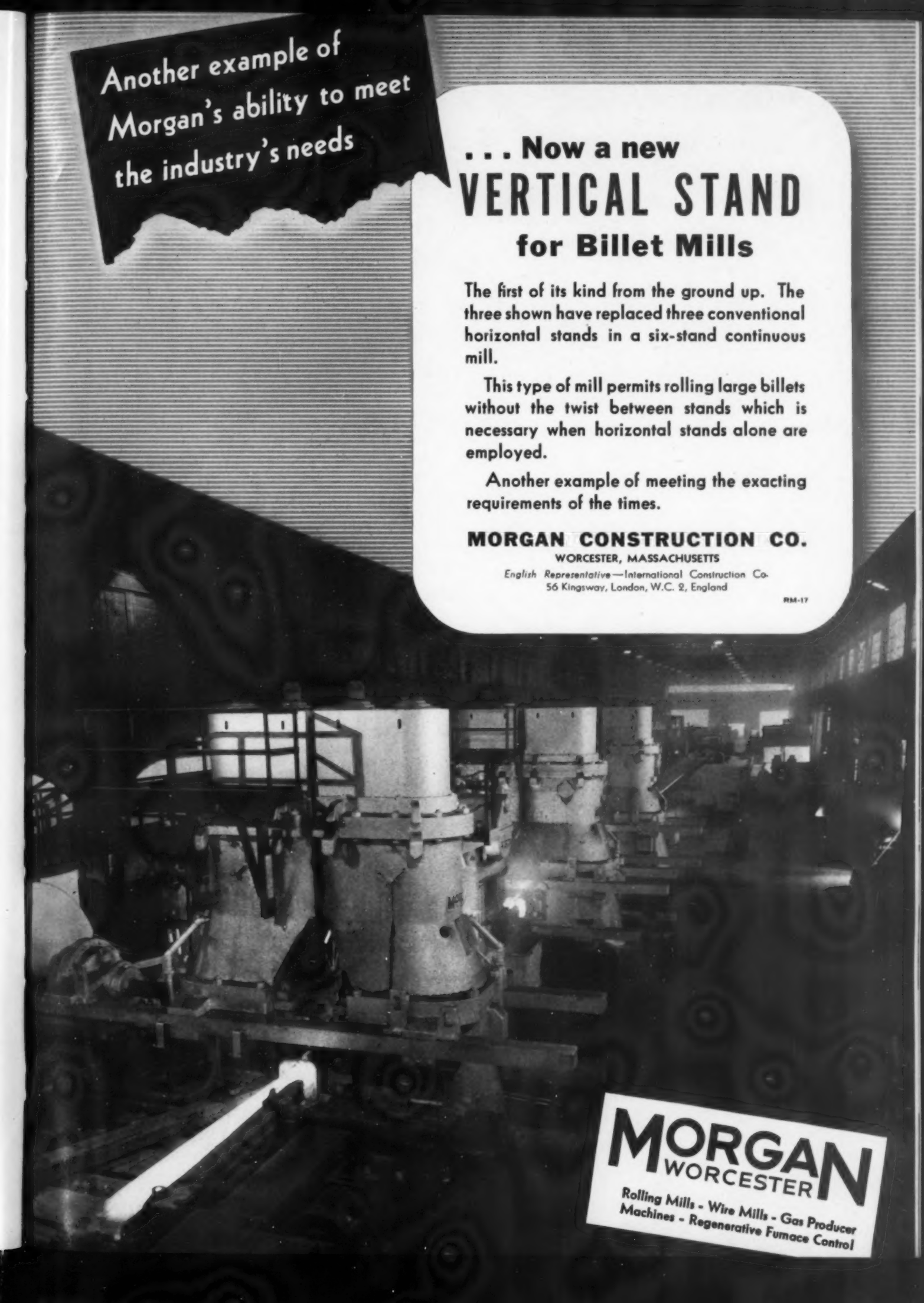
April 29

▲ The Westinghouse Electric Corporation announced today that its price reductions since the first of the year have totaled more than $14,000,000 on household and industrial electrical equipment. Approximately two-thirds of this price reduction went into effect in the last week of April.

▲ President Benjamin F. Fairless of the United States Steel Corporation announced product price reductions ranging from $1 to $5 per ton on a wide variety of steel products. Products for which lower prices were posted include wire products such as nails, barbed wire, fencing and other wire products; tin plate, cold rolled strip and sheet. Mr. Fairless also announced the elimination on May 1, of the current differential of $3 a ton at Geneva, Utah, on prices of steel products produced there by Geneva Steel Company. For the first time in the history of the steel industry, a western mill has announced prices at a parity with those for similar products produced by steel mills in the east.

April 30

▲ R. M. Bartlett, vice president of Gulf Oil Corporation, stated today that the production of petroleum from shale at the present time offers a logical approach to the problem of manufacturing synthetic gasoline and diesel fuel. The development of synthetic manufacture of petroleum fuels from shale represents a net addition to our national fuel resources since shale is not suitable for any other purpose. He also stated that for each ton of steel used, from five to ten times as much oil can be produced in countries outside the United States as can be produced domestically with the same amount of steel. The reason for this lies in the comparatively shallow oil fields in the Middle East and the tremendous volume of oil per well. The average daily production of crude in the United States is about 12 barrels per well; in Venezuela, about 250 barrels; and in the Middle East, about 4000 barrels.


Another example of Morgan's ability to meet the industry's needs
. . . Now a new
VERTICAL STAND
for Billet Mills
The first of its kind from the ground up. The three shown have replaced three conventional horizontal stands in a six-stand continuous mill.
This type of mill permits rolling large billets without the twist between stands which is necessary when horizontal stands alone are employed.
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Personnel News . . . .

Edmund G. Price has been elected vice president in charge of operations of the National Tube Company. Mr. Price, a native of DuBois, Pennsylvania, graduated from Pennsylvania State College in 1924. Immediately after graduation, Mr. Price was employed at the Lorain, Ohio, plant of National Tube, serving in various operating positions until 1931, when he became superintendent of blast furnaces there. He was appointed general superintendent of Lorain works in 1941, serving in that capacity until 1944, when he became an executive assistant in the operating department in National Tube's general offices in Pittsburgh. He was appointed general superintendent of the company's National works at McKeesport in 1946, where he served until his election as vice president.

Ralph M. Overton, who has been on the staff of the vice president of engineering and operations, U. S. Steel Corporation of Delaware has been appointed assistant vice president of operations of National Tube Company. Mr. Overton was born in Winchester, Illinois, and is a graduate of the University of Illinois. He joined National Tube in 1924 and held various engineering and operating positions with the company. He was previously general superintendent of National works.

T. H. Kennedy has been named general superintendent of National works of National Tube Company, McKeesport, Pennsylvania. Mr. Kennedy was born in Big Stone Gap, Virginia, and received his bachelor of science degree in metallurgy from Missouri School of Mines and Metallurgy. He had wide experience in the iron and steel industry before joining National Tube as assistant superintendent of blast furnaces at National works in 1940. In 1946, he was made assistant general superintendent of National works.

Robert S. B. Holmes has been appointed director of training and safety for National Tube Company. Mr. Holmes had been assistant supervisor of education and training for Carnegie-Illinois Steel Corporation. He was born in Pittsburgh, attended the Dormont public schools and upon his graduation from Pennsylvania State College, he joined Carnegie-Illinois in the maintenance department. He was transferred to industrial relations where he had wide experience in both training and safety.

Lester M. Curtiss who has been general manager, steel plants, of Lukens Steel Company today was named general works manager of the company and its divisions, By-Products Steel Company and Lukenweld.

Mr. Curtiss, a native of Norfolk, Connecticut, joined Lukens Steel Company in 1919 as assistant engineer of tests, holding this position until 1923 when he was made engineer of tests. In 1925 he was named assistant superintendent of plate mills, serving in that capacity until 1928 when he was appointed superintendent of Lukens 140- and 206-in. mill — the world's largest plate mill. In 1932, he was promoted to superintendent of plate mills, in charge of all mills of the company and in 1935, he was again promoted to superintendent of production, in charge of all production facilities of the company which position he retained until he was named assistant general superintendent in 1936. He was named general superintendent in 1939 and general manager, steel plants in 1946.

Curtis A. Gordon, formerly superintendent of blast furnaces, Wickwire-Spencer steel division, Colorado Fuel and Iron Corporation, Buffalo, New York, is now vice president in charge operations, Jessop Steel Company, Washington, Pennsylvania.

J. J. Buckley was recently elected president of Pacific Tube Company, Los Angeles, California. Since 1944 Mr. Buckley has held the position of vice president and general manager of this company. During the eight years prior to his going to the west coast, he was associated with a sister company, Superior Tube Company.

William S. Hough, formerly manager of the chemical and aviation sections of the Johns-Manville Corporation's special industries department at New York, will assume Mr. Frankland's former duties in Chicago

EDMUND G. PRICE

RALPH M. OVERTON

T. H. KENNEDY

LESTER M. CURTISS

as assistant district manager, industrial products division. In addition to his experience as a sales manager in the chemical and aviation fields, Mr. Hough served in many other sales capacities during 22 years with Johns-Manville in New York, New York, and Newark, New Jersey, where he made his headquarters for nearly 10 years. Mr. Hough was graduated from Rutgers University with a bachelor of science degree in chemistry.

George R. Frankland was named Chicago district manager of Johns-Manville's industrial products division. Mr. Frankland succeeds **Corydon H. Hall,** who resigned April 1, to become president and chief executive officer of a new company being organized in California.

A. G. Pratt was elected chairman of Babcock and Wilcox Company. Mr. Pratt has been with the company for 45 years, during seven of which he served as a vice president and 24 years as president.

Alfred Iddles was chosen president of Babcock and Wilcox Company, New York, New York. Mr. Iddles, who has been engaged in engineering and construction work all his business life, joined the company in 1937 and became a vice president in 1945.

Peter D. White has been elected president of the Babcock and Wilcox Tube Company, Beaver Falls, Pennsylvania. Mr. White has been with the Babcock and Wilcox organization 33 years. During the past year he has been executive vice president and a director and was previously a vice president for five years. Mr. White is a graduate of Massachusetts Institute of Technology.

Luke E. Sawyer, who has been general superintendent of the Babcock and Wilcox Tube Company since 1939, was elected vice president and general manager. He has been with the organization 37 years. He is a graduate of Massachusetts Institute of Technology.

E. A. Livingstone, who has been general sales manager of Babcock and Wilcox Tube Company since 1939, was elected vice president in charge of sales. He has been with the company 18 years. He is a graduate of McGill University.

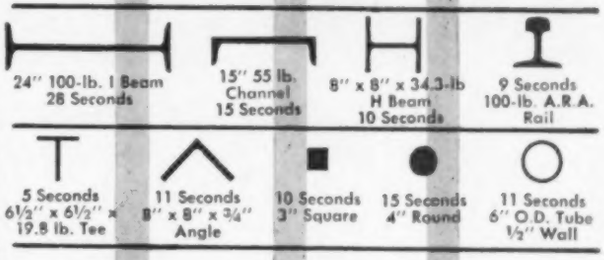
W. H. Rowand was named chief engineer of Babcock and Wilcox Company on April 8, 1948. The position is a new one created by the recent promotion of Alfred Iddles to the presidency of the company. Mr. Rowand will assume most of the engineering activities previously handled by Mr. Iddles. Mr. Rowand has been with Babcock and Wilcox Company for 19 years. He studied mechanical engineering at Cornell University, class of 1929, and later carried out post-graduate work at Columbia University. During his years with the company, Mr. Rowand has served in many engineering capacities and has been active in the design and development of boilers.

C. C. Wiley was appointed Baltimore, Maryland district sales manager for Link-Belt Company. Mr. Wiley started his Link-Belt career in 1926 at the Philadelphia plant as secretary to the chief engineer. In 1927, he became assistant manager of the Philadelphia plant's quick-service factory branch store. He was transferred to the Pittsburgh office in 1929, where he served customers for a period of 17 years, specializing on conveyors and drives for steel mills. He had been district sales manager at Birmingham since 1946.

J. T. Bell, Jr., was named Birmingham, Alabama,

Modern Sawing

with KLING HIGH SPEED FRICTION SAWS



Friction sawing is one of few mechanical processes which employ the heat of friction in a useful manner. It concentrates heat on the material to be severed at a rate which is faster than it can absorb heat. The immediate temperature rise of the contact surface is so great that its strength is reduced considerably lower than that of the colder blade rim. This heated surface is readily removed by the blade and permits complete severing of the material rapidly with no loss of metal from the blade.

Because of its versatile ability to cut many varied structural shapes, as well as solid or hollow bars in any sequence, without change of blade or set-up, one machine can handle a volume of cutting that would otherwise require several separate shears or slow speed saws.

Consult Kling engineers regarding your metal cutting problems. State size of material to be cut. Bulletin No. 9200 giving full particulars and suggestions as to the type and size of saw will be mailed promptly. No obligation.

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No. 2 Only one wrench needed to remove blown link and renew.

No. 3 Rugged simplicity. Only 3 parts to handle in renewing link.

No. 4 HI-LAG Link of one piece, uniform thickness, has large contact areas—wide body areas to insure dependable absorption of heat for time lag.

No. 5 Arched spring tension washers and heavy studded bolt, keeps links permanently tight. Reducing excessive heat and needless blows.

WARE HI-LAG FUSES have many exclusive features in design and construction which make them far superior in operation—much more economical in rendering longer fuse life and with unsurpassed safety insurance.

Try WARE HI-LAG FUSES NOW! Start enjoying uninterrupted production progress and new fuse economy with the World's Best and Coolest Operating Renewable Fuse.

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district sales manager of Link-Belt Company. Mr. Bell, a native of Florida, attended Marion Military Institute, Marion, Alabama, and received his bachelor of science degree in civil engineering at Georgia School of Technology in 1942. From college, he went directly into the U. S. Army, Corps of Engineers, serving 35 months overseas. Mr. Bell joined the Link-Belt Atlanta plant organization in January, 1946, where he has successively worked in the Atlanta branch sales, engineering, order and estimating departments in the process of receiving an intensive training course on the construction and application of Link-Belt products to all types of industries.

Bruce E. Tau has recently been elected a vice president of Freyn Engineering Company. He has been identified with the company since 1931.

BRUCE E. TAU

George C. McCormick was placed in charge of a newly formed heat treating division of Loftus Engineering Corporation.

C. Howard Nold, Philadelphia district sales manager of Harbison-Walker Refractories Company, has retired after a service of 45 years, in accordance with the company's retirement plan. First associated with the Pittsburgh general office of Harbison-Walker, Mr. Nold served in various capacities including sales and operating until World War I when he was in charge of the export department. He has been sales manager of the Philadelphia district since 1919.

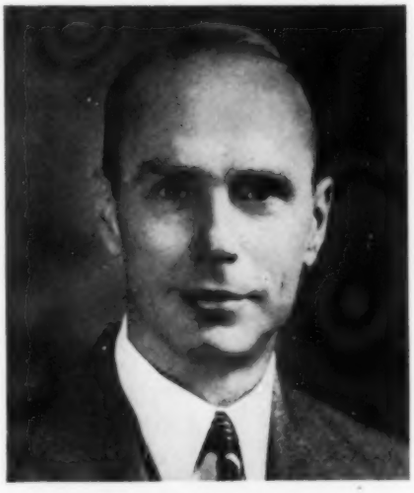
Fred C. Boyce was re-elected president of the D. J. Murray Manufacturing Company. The other officers elected are: **M. P. McCullough,** vice president; **C. E. Staky,** executive vice president and general manager; **J. S. Alexander,** treasurer; and **A. W. Plier,** secretary and assistant manager. The following directors elected in addition to Mr. Boyce are: M. P. McCullough, C. E. Staky, J. S. Alexander, A. W. Plier, D. C. Everest, Grover Keeth, and G. L. Ruder.

Charles F. Hanks, Jr. recently joined the research department of Harbison-Walker Refractories Company, Pittsburgh, Pennsylvania. Mr. Hanks was formerly associated with the Westinghouse Electric Corporation in the research laboratory at East Pittsburgh, Pennsylvania, and Emeryville, California. He is a graduate of

the University of Illinois with a degree of bachelor of science in ceramics in 1940.

John A. Slenker has been appointed general superintendent of the Duluth, Minnesota works of American Steel and Wire Company. He succeeds **F. J. Martin,** deceased. Mr. Slenker is a native of York, Pennsylvania, having been born there on November 19, 1907. He attended public schools in that city before matriculating at Penn State College from which institution he was graduated with a bachelor of science degree in metallurgy. His first business experience was with the York Ice Machinery Company. He subsequently worked for the Aluminum Company of America and Jones and Laughlin Steel Corporation before joining the American Steel and Wire Company in June, 1935, as assistant metallurgist at the Donora, Pennsylvania, works. In November, 1940, he was transferred from the position of superintendent of the open hearth in Donora to the job of Cleveland division metallurgist of the wire company. In June, 1942, he was moved to South works, Worcester, Massachusetts, as superintendent of the steel works. Since August, 1945, Mr. Slenker has been assistant general superintendent at Duluth.

H. S. Schweinsberg, of Harbison-Walker Refractories Company, has been appointed sales manager of the Philadelphia district to succeed C. Howard Nold, who was recently retired.



H. S. SCHWEINSBERG

Associated with Harbison-Walker for more than 20 years, Mr. Schweinsberg was formerly assistant district sales manager of the Philadelphia district.

Charles R. Hook was elected chairman of the board of Armco Steel Corporation today, and **W. W. Sebald,** executive vice president, was elected president of the corporation. Mr. Hook, who has been president since 1930, will continue as chief executive officer.

Mr. Sebald has spent practically his entire business career with Armco, joining the corporation in 1906. His first position was that of office boy. At 19 years of age, he became a salesman, and for a time was the company's only regular traveling salesman. In 1912 Mr. Sebald was sent to New York to open Armco's first district sales office. He joined the navy in World War I and emerged at the war's end as an Ensign. In 1919 he was recalled to Armco's home office in Middletown to

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become assistant general manager of sales. He was appointed assistant vice president in 1923.

Mr. Sebald was elected vice president in charge of commercial activities in 1926, and a director of the corporation in 1938. He became executive vice president in 1947.

Mr. Hook began his career in the steel industry as a $2.00 a week office boy for a little steel plant in Cincinnati. After that plant was acquired by a large steel corporation he took a job on the bar gang in one of the corporation's tin mills in Indiana to learn the practical side of steelmaking. In that same plant he completed his apprenticeship as a roll turner.

In 1902 he joined the Armco organization in Middletown as night superintendent. In his upward climb he held many executive positions, such as general superintendent, vice president in charge of operations, vice president and general manager, and, on January 1, 1930, was elected president.

R. L. Puette, for the past year vice president in charge of manufacturing and production for Clark Con-

R. L. PUETTE

troller Company, Cleveland, Ohio, was elected a director of the company, April 6, 1948.

Lawrence F. Black has been appointed assistant chief engineer of American Steel and Wire Company. Mr. Black was born in Pittsburgh, Pennsylvania, on September 9, 1907, and attended the public schools at Donora, Pennsylvania, before entering Carnegie Institute of Technology where he majored in civil engineering. His first experience with American Steel and Wire Company began in 1924 when he was hired as a clerk at the Donora, Pennsylvania, zinc works. The following year he moved over to Donora wire works as a layer out. He subsequently held a variety of jobs at both the zinc works and wire works before being transferred in May, 1943, to Duluth, Minnesota, as general master mechanic. Since January, 1945, Mr. Black has been superintendent of engineering and maintenance at Duluth which post he now leaves to assume his new duties.

Charles B. Hull has been named assistant division engineer—construction for American Steel and Wire Company. Mr. Hull is a native of Onaway, Michigan, and was graduated from the University of Michigan with a bachelor of science degree. He has been with the

wire company since July, 1925, when he started as a draftsman in the chief engineer's office in Cleveland. He progressed through the ranks and was works engineer at Cuyahoga works in Cleveland prior to his appointment in June, 1945, as chief draftsman in the engineering department, the position he has held up to the present time.

L. P. McAllister was appointed manager of steel plants of Lukens Steel Company, Coatesville, Pennsylvania. Mr. McAllister, a native of Philadelphia, joined Lukens Steel Company in 1922, following his graduation from Brown University. He has served successively as assistant manager of tests, engineer of tests, metallurgical sales engineer and metallurgical engineer until 1944, when he was appointed assistant to the general superintendent. He was named assistant general manager of steel plants in April 1947.

L. V. Johnson was appointed assistant chief engineer of National Tube Company. Mr. Johnson's entire career has been with National Tube. He has held various operating and engineering positions, and was formerly general superintendent of the company's Christy Park works, McKeesport, Pennsylvania. Recently, he has been chief project engineer in charge of the company's extensive modernization and improvement program at Gary, Indiana.

Walter E. Harvey was appointed director-product development and research to supervise John C. Dolph Company's new, intensive research program. Mr. Harvey joins Dolph with a wide background of experience. He graduated with a bachelor of science degree in chemical engineering from Pennsylvania State College in 1932 and a master of science degree in science and chemistry from the University of Pennsylvania in 1933. He also was an instructor in chemistry at Drexel Institute. Mr. Harvey has been associated with several companies in the chemical field, and, for nine years, held an important position with one of the country's leading manufacturers of insulating varnish.

W. R. Hough, chief engineer since July 1945, was elected engineering vice president of Reliance Electric

W. R. HOUGH

and Engineering Company. Mr. Hough was born in Kalamazoo, Michigan and joined Reliance in 1929, following graduation in electrical engineering from the

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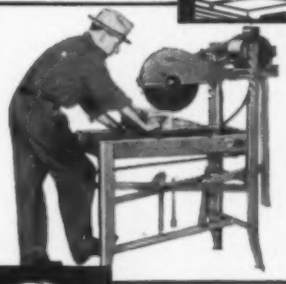

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University of Michigan. Prior to his becoming chief engineer he had served successively as junior engineer, chief draftsman, alternating current design engineer and product development engineer.

Obituary

George E. Reiser was killed on March 16 in an automobile accident in his home city of Buffalo, New York. Mr. Reiser was born in 1908 and had been employed for 12 years by the Bethlehem Steel Company

GEORGE E. REISER

at Lackawanna, New York. In March 1946 he became associated with the A. W. Reiser Company, who represented the American Car and Foundry Company, valve division, in Buffalo.

Joseph H. Slater, assistant manager of the Cleveland district of the Republic Steel Corporation and chairman of the company's blast furnace and coke committee, died suddenly in his office at the Cleveland plant in March, 1948. He had been with Republic since 1930.

Mr. Slater was born in Detroit 54 years ago and was educated in the schools there and in Cleveland, to which he was brought as a boy. He was graduated from Glenville High School and obtained his engineering education at Case School of Applied Science. His first work in the steel industry was in the blast furnace departments of the American Steel and Wire Company at Cleveland and the National Tube Company at Lorain.

In 1920 he became superintendent of the Canton blast furnace plant of the United Alloy Steel Company. He continued in that capacity until 1926, when the United Alloy and the Central Steel Companies merged into the Central Alloy Steel Company. Then he assumed also supervision of the former Central Steel Company furnaces at Massillon, Ohio. Central Alloy became a part of the newly formed Republic Steel Corporation in 1930, and in 1932 Mr. Slater was transferred to the Warren district as superintendent of blast furnaces and coke ovens for Republic. Three years later he took the

same position at the former Corrigan-McKinney Steel Company.

In 1940 he was promoted to assistant district manager. For a while he was acting district manager in the temporary absence of James L. Hyland, who was on an assignment in Europe for the United States government.

Mr. Slater was for 15 years chairman of the blast furnace and coke committee of Republic.

Thomas E. Doyle, the first employee of Dravo Corporation, and president of Dravo-Doyle Company from 1908 to 1925, died April 1, at the age of 85. Mr. Doyle, a native of Blairsville, Pennsylvania, became associated with Francis R. Dravo, shortly after F. R. Dravo and Company was organized in 1891. He supervised early machinery installation projects for engines, boilers and pumps at power plants, waterworks and other facilities, and was closely connected with the firm's growth and activity. In 1901, when Dravo-Doyle Company was organized, he joined that company and became its president seven years later, a post he held until his retirement in 1925.

Swen W. Nelson, manager, Buffalo office, Bailey Meter Company, died suddenly April 12. Funeral services were held in Buffalo on Friday, April 16 and burial was at Clyde, New York. Mr. Nelson joined Bailey Meter Company shortly after its founding. In 1917 he was granted a leave of absence and served in the army during World War I. In 1919 he returned and was assigned to the Cleveland plant and in 1921 he was transferred to the Buffalo branch office as a sales-service engineer. In 1923 Mr. Nelson was appointed branch manager of the Buffalo office, the position he held at the time of his death.

Karl W. Atwater, industrial consulting engineer, Investment Building, Pittsburgh, Pennsylvania, died suddenly at his home April 9, 1948.

Alexander L. Bletz, plant engineer for a number of years for SKF Industries, Inc., of Philadelphia, Pennsylvania, died April 1 following a long illness. He was 53 years old. For the past two years he had acted in an advisory capacity on plant engineering problems for the ball and roller bearing firm. A native of Germany, Mr. Bletz joined SKF in 1928 after having spent five years in Spain and North Africa as consulting engineer on electrical installations and two years with the Philadelphia Electric Company.

Revolving Heaters for Thorough Heat Coverage

The remarkable feature of Wing Revolving Unit Heaters that distinguishes them from other types of heating systems is the fact that the discharge outlets **revolve.** This assures a thorough circulation of the heated air to all parts of the working level regardless of obstacles.

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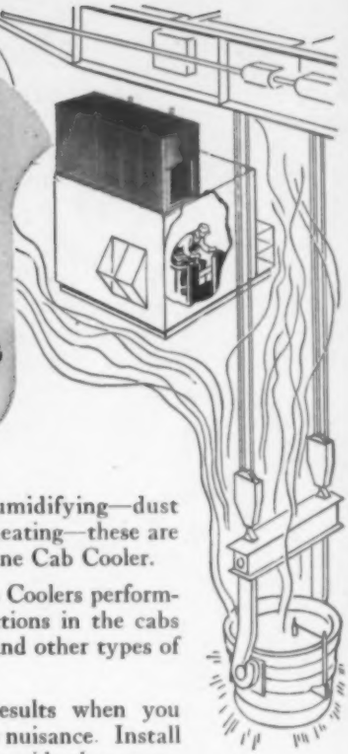

Cooling—fume removal—dehumidifying—dust filtering—ventilating—winter heating—these are the functions of the Dravo Crane Cab Cooler.

You will find Dravo Crane Cab Coolers performing these air conditioning functions in the cabs of soaking pit, ladle, stripper, and other types of hot-metal cranes.

And you will observe real results when you eliminate heat fatigue and fume nuisance. Install Dravo Crane Cab Coolers to provide these comfortable working conditions in the cabs of hot-metal cranes.

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Pictorial

AISE SPRING

HOTEL STATLER, BUFFALO, N.Y.

The 1948 AISE Spring Conference held in Hotel Statler, Buffalo, New York, on April 26 and 27, was one of the most successful ever held. Representatives from nearly every steel plant were included among the 950 total attendance.

Stoking up on coordination and bacon and eggs, the authors and chairmen are seen (1) at a typical breakfast. Preceding each day's technical session the authors and chairmen met together to go over the day's program. This long-established feature of AISE national meetings makes for a fast-moving schedule of technical sessions.

The sessions opened in the Chinese Room at 9:15 a.m., April 26, with (2) (sitting) Bruce Bargman, Carnegie-Illinois Steel Corporation and E. T. W. Bailey, Steel Company of Canada, Ltd., acting as co-chairmen, and (standing) C. E. Peck, Westinghouse Electric Corporation and J. D. Keller, Associated Engineers, who presented papers.

In (3) are seen the participants in one of the afternoon sessions which was held at 2:00 p.m., April 26, in the Fillmore Room. They are Lloyd L. Wilson, Cold Metal Process Company, J. S. Apperson III, General Electric Company, I. N. Tull, Republic Steel Corporation, H. S. Maxwell and C. W. Clapp, General Electric Company, and R. W. Graham, Bethlehem Steel Company.

At the simultaneous session which was held in the Chinese Room at 2:00 p.m., April 26, were (4): James N. Imel, Jones and Laughlin Steel Corporation, C. W. Barrett, Republic Steel Corporation, A. M. Cameron, Atlas Steels, Ltd., W. J. Barry, Bethlehem Steel Company, Charles P. Hammond, Atlas Steels, Ltd., and J. A. Tischbein, Jones and Laughlin Steel Corporation.

The next morning at 9:00 a.m., at the session held in the Chinese Room, (5) Earl M. Anger, Duraloy

Review CONFERENCE

APRIL 26-27 1948

Company, goes over his paper with F. S. Eckhardt, Bethlehem Steel Company.

Monday evening, preceding the dinner which was held in the Ball Room, a Speakers' Reception was held in the Grover Cleveland Room. Among those present were (6): R. A. Schneid, Crucible Steel Company of America, F. C. O'Brien, Burlington Steel Company, Ltd., W. R. Breeler, Allegheny-Ludlum Steel Corporation, and C. F. Anderson, Page-Hershey Tubes, Ltd. Also in attendance were (7): F. A. Sherman, Dominion Foundry and Steel Company, R. H. Davis, Atlas Steels, Ltd., and F. C. Farrel, Republic Steel Corporation.

A. J. Fisher, AISE president, welcomes (8) R. A. Gillies, Steel Company of Canada, Ltd., who spoke on the economics of the Canadian steel industry, and A. K. Shonkwiler, Bethlehem Steel Company. Mr. Shonkwiler was host to the AISE on Tuesday, April 27, upon the occasion of an inspection trip through the Lackawanna works of Bethlehem Steel Company.

The candid camera caught the following on a tour of the conference: (9) Carl Johnsey, Connors Steel Company, R. E. Bobbitt, Jr., Atlantic Steel Company, and Ralph H. Scholl, Pittsburgh Rolls division, Blaw-Knox Company. John F. Black, Wickwire-Spencer Steel Division, Colorado Fuel and Iron Corporation, is photographed (10) with Walter C. Haus, Blaw-Knox Company, and C. E. Duffy, Bethlehem Steel Company. Robert Lerner is seen in (11) with Francis G. Kredell, Earl Tindal, and George Pimlott, all of Republic Steel Corporation.

Sheridan A. Smith, Steel Company of Canada, Ltd., chats with A. A. Britton, Carpenter Steel Company, J. J. Hein, Inland Steel Company, R. A. Hawkinson, Republic Steel Corporation, and Robert Gourlay, Algoma Steel Corporation, Ltd.

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Modern Blooming-Slabbing Mill Uses amplidyne-controlled TWIN DRIVES

Higher reversal and average speeds, larger tonnages made possible by amplidyne control of acceleration, deceleration, torque balance, and speed

In a large steel mill west of the Mississippi, one big reason for the 45-in. blooming-slabbing mill's high output is the G-E twin-motor reversing drive. Keyed to an adjustable-voltage amplidyne control system, this drive gives the operator an improved method of maintaining voltage for any given operating point, permits the higher average speeds that increase mill production. It also gives these specific advantages:

—**Provides** accurate control of acceleration and deceleration, maintaining maximum rates at all times. After running in one direction for a few revolutions, the mill can be quickly reversed (from base speed to base speed in 1½ seconds or less).

—**Assures** effective control of load limits, making maximum torque output of motors available as needed, for heavy passes at low speed and lighter passes at higher speed.

—**Reduces** the number of control devices required by about half, greatly simplifying the control scheme.

—**Maintains** accurate load balance between two or more machines operating in parallel, and proper torque and speed balance on both units of the twin-drive.

—**Keeps** motors and generators fully protected at all times against overcurrent, overvoltage, and overspeed for greater service continuity, longer equipment life.

—**Provides** definite, easily-selected speed points in both forward and reverse; permits low creeping speed to keep rolls turning slowly between passes for uniform cooling; eliminates creeping when necessary to line up couplings for changing rolls.

Whether you plan to install a new reversing-mill drive or modernize an existing one, General Electric can meet your need for higher speed and more accurate control. Call in a G-E steel mill engineer to talk it over. There's no obligation. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

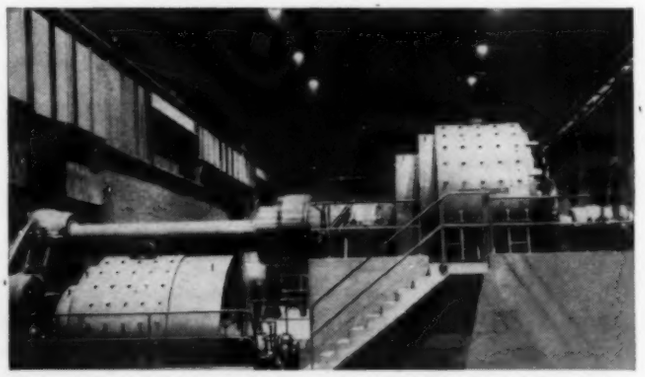
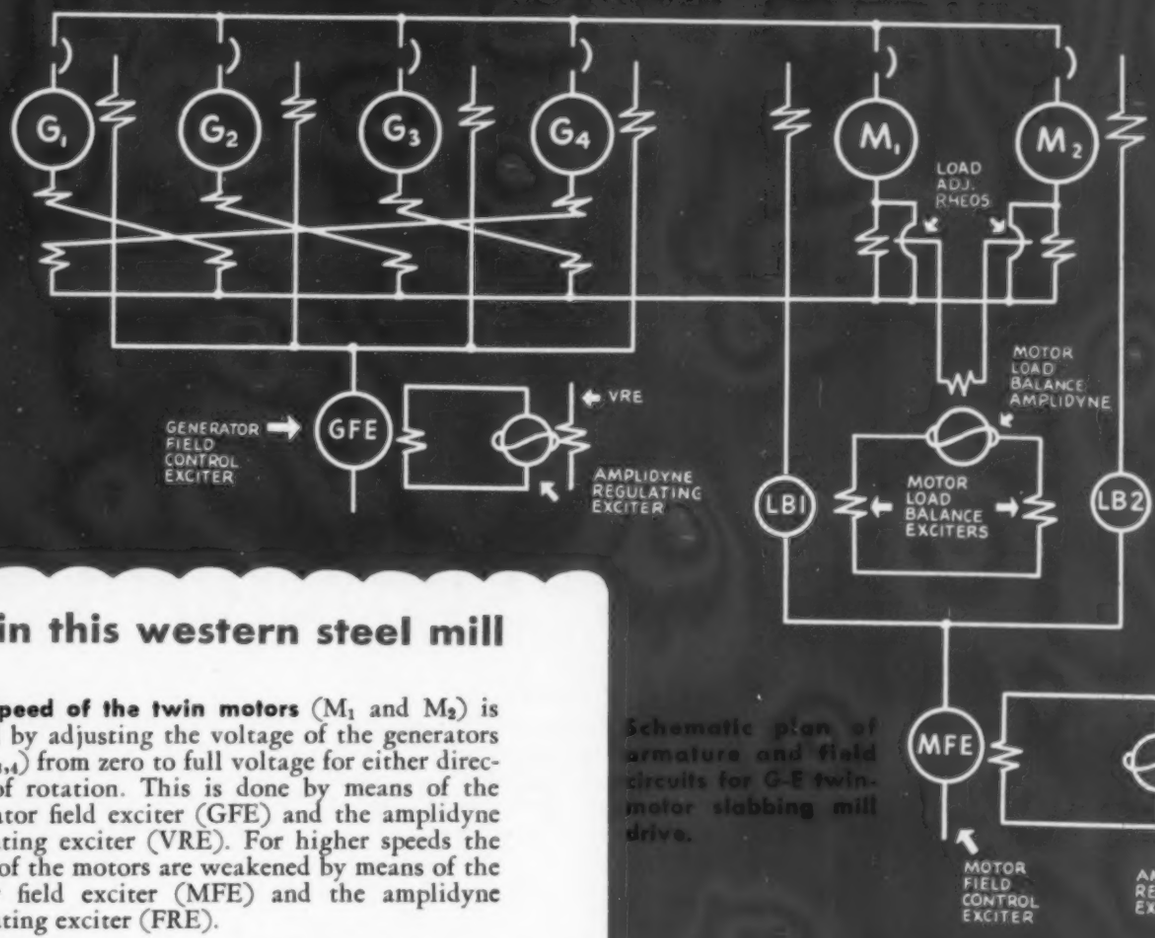


Photo shows the G-E twin-drive motors used in a 45" x 115" reversing slabbing mill. Each d-c motor is 5000 hp, 40/80 rpm, 750 volts.

GENERAL ELECTRIC

HOW THE G-E DRIVE WORKS . . .



Schematic plan of armature and field circuits for G-E twin-motor slabbing mill drive.

. . . in this western steel mill

The speed of the twin motors (M_1 and M_2) is varied by adjusting the voltage of the generators ($G_{1,2,3,4}$) from zero to full voltage for either direction of rotation. This is done by means of the generator field exciter (GFE) and the amplidyne regulating exciter (VRE). For higher speeds the fields of the motors are weakened by means of the motor field exciter (MFE) and the amplidyne regulating exciter (FRE).

The regulating exciters (VRE and FRE) cause the twin motors (M_1 and M_2) and the mill to operate in a direction and at a speed determined by the position of the operator's master switch. In doing so, these amplidynes automatically limit the armature circuit current to a definite value. If, when operating with weakened motor fields, the operator tries to take an excessive draft, the amplidyne (FRE) acts to limit armature current. This it does by strengthening the motor fields, thereby supplying increased torque at lower speed.

Motor M_1 drives the upper work roll. Motor M_2 drives the lower work roll. Motor load balance amplidyne (LB) measures the difference between the two motor load currents. Amplidyne (LB) supplies excitation to the motor load balance exciters (LB_1 and LB_2) so as to strengthen the field of the motor carrying the higher load and weaken the field of the motor carrying the lower load. This restores the load current balance.

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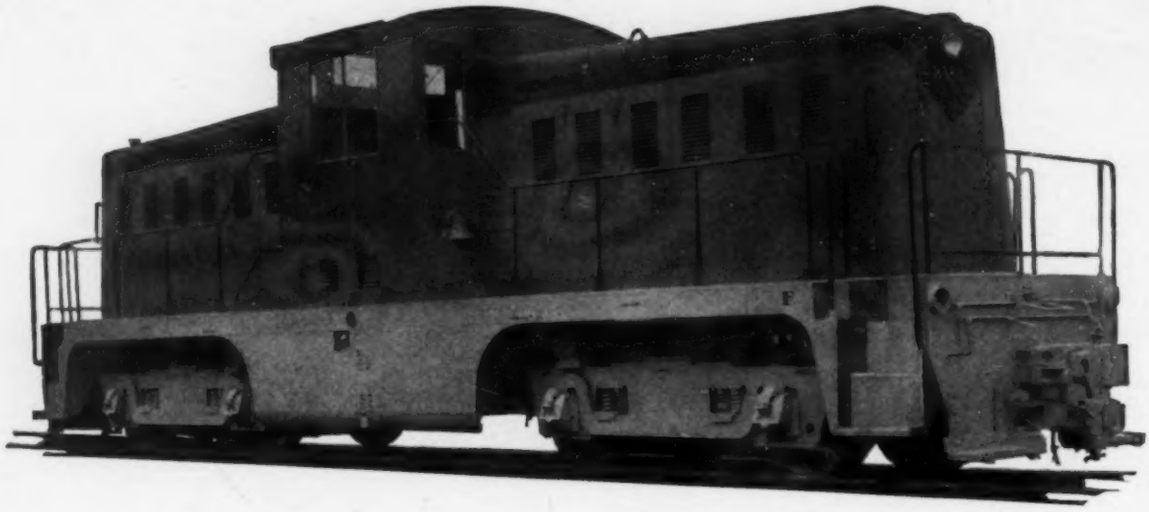

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The complete absence of smoke and steam in switching and hauling operations conducted with Whitcomb Diesel locomotives, is an important safety factor. Ground signals transmitted to the operator are easily and surely received, resulting in safer train movements and less fatigue for the crew.

Accidents due to poor visibility are materially reduced; easier, smoother, switching and hauling result because the operator's vision is never clouded by dense smoke or steam. He can see where his locomotive is going and what's on the track ahead of him.

The economies that are possible in reduced maintenance and operating costs should be reason enough to replace all your steam locomotives with Whitcomb Diesels. The safety factors including the lowering of the accident rate are important additional reasons why Whitcomb Diesel locomotives should be doing all your switching and intra-plant hauling.

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DIESEL MECHANICAL LOCOMOTIVES FROM 3 TO 30 TONS

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First, cost of lubricating oil is eliminated entirely. A-B-K bearings are successfully lubricated with *water*.

Second, A-B-K bearings cut power consumption from the start.

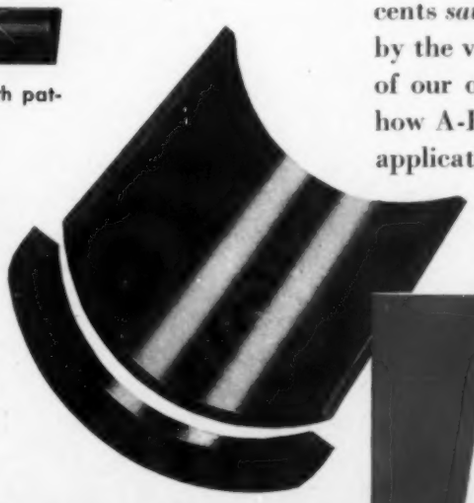
Third, A-B-K bearings hold gauge longer —require fewer adjustments—reduce costly shutdowns.

Fourth, A-B-K Laminated Plastic Bearings actually outwear metallic bearings. The material in these bearings is exceptionally tough and slow-wearing. It will not distort under shock and is highly heat-resistant. Actually polishes—never scores—the shaft!

Add up these advantages of A-B-K Laminated Plastic Bearings in terms of dollars and cents *saved*. An A-B-K representative, backed by the vast research and engineering facilities of our organization, will be glad to tell you how A-B-K bearings can cut costs on specific applications in your mill.

A-B-K slipper bearing with patented reinforced edge.

Phantom view of slipper bearing.



A-B-K roller neck bearing with separate collar.

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Laminated Plastic Bearings

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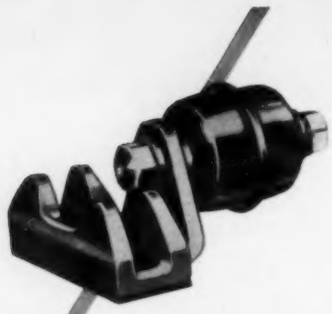

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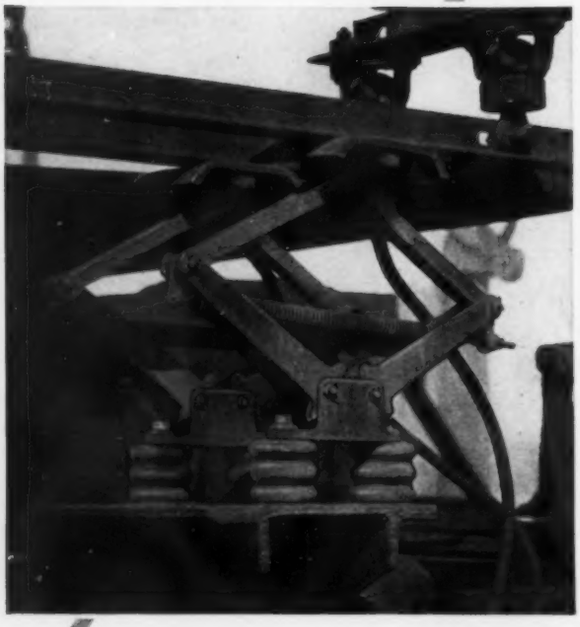

Electric Service manufactures a complete line of Keystone Current Collectors that are standard equipment in many of the nation's leading industries. From the small crane trolley collector shown above to the large pantagraph collector at left, there is a type and size suitable for practically any kind of crane, conveyor, or other work requiring a moving power contact.

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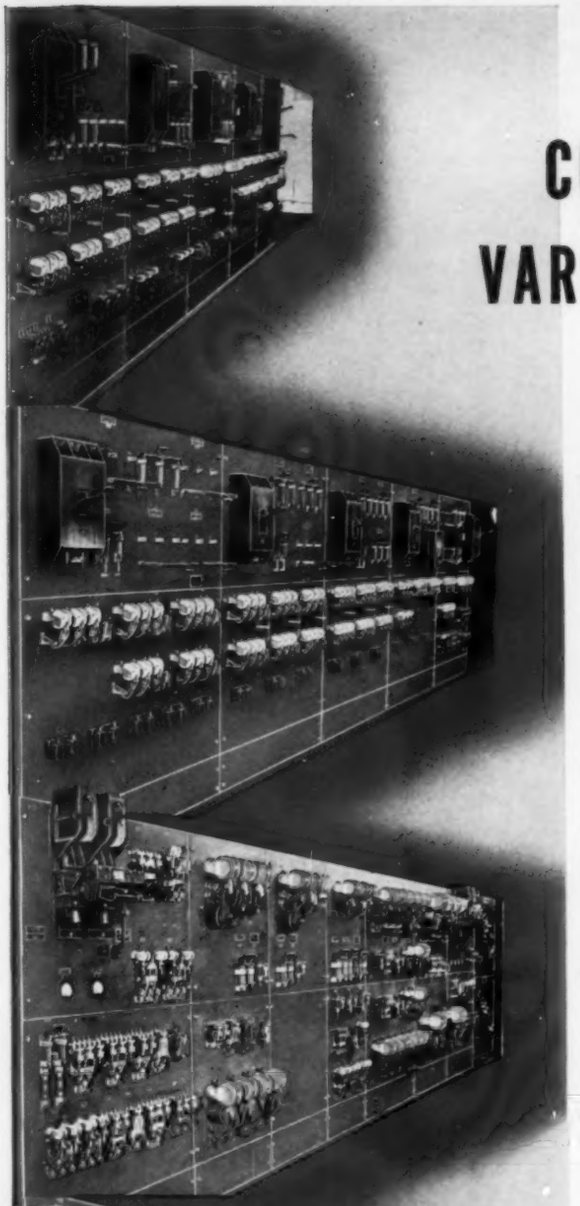

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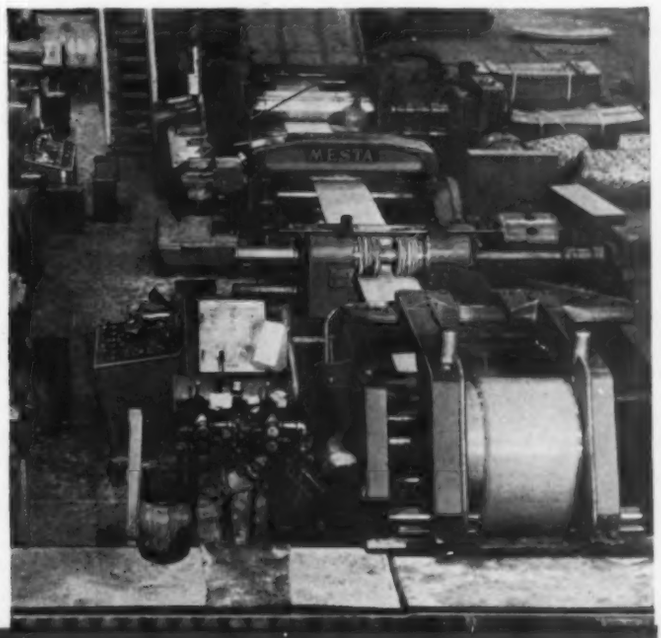
CONTROL FOR HIGH SPEED VARIABLE VOLTAGE PICKLE LINE

This High Speed Pickle Line operates successfully with CLARK Heavy Duty Control, which incorporates the latest ideas in Variable Voltage Equipment.

CLARK ENGINEERS specialize in designing Heavy Duty Mill Control. CLARK Heavy Duty apparatus is engineered to control every mill function and deliver maximum service with minimum maintenance.

The proof of these statements is found in the hundreds of *processing lines* for which CLARK engineered and built the controls.

For every Heavy Duty Mill Control problem, consult your nearest CLARK application engineer.



EXIT END OF PICKLE LINE

EVERYTHING UNDER CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152nd STREET, CLEVELAND 10, OHIO

THESE COILERS

COMPENSATE QUICKLY FOR CHANGES IN ROD SPEED

Two vertical, platen-raising type coilers, equipped with motor drive and air-operated pushers for removing the coils to a conveyor.

Built to handle nonferrous hot rod from an extrusion press, these Farrel coilers are equipped with special clutches which allow sufficient slippage to compensate for variations in the speed encountered in press extrusion of this type of material. The coiling basket is of comparatively light, low-inertia construction to permit quick response to changes of rod speed. For emergency stops, solenoid-operated band brakes are provided.

Conventional features include adjustable-speed motor drive through an enclosed spur gear reduction and cut bevel gears . . . platen mounted on the center shaft which passes down through the main vertical shaft for connection with the air cylinder . . . air-operated coil pusher for removing the coils to conveyor . . . and unit bedplate of high-strength Meehanite metal for positive stability during operation.

These coilers are another example of Farrel equipment designed and built to fit the job. Write for details of any of the production machinery listed on this page.

FB-438

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MAY, 1948

(1) Backstop

The new Falk backstop provides a positive method for preventing reverse rotation on conveyor drives, elevator head shafts, windlasses, winches, and on all applications where reverse rotation should not occur. "Back-run" or reverse rotation, in some machinery operations, may cause serious damage to the machinery and the material being handled. In addition, expensive production delays may result. The gripping action of the new backstop takes place at the precise moment that forward rotation ceases. It reduces the possibility of shock or strain to a minimum. (10,080). Falk Corporation.

(2) Coal Cleaning

Information on four coal cleaning systems with explanatory circuits, illustrations of machines, and diagrams of operation are packed into a new 20-page coal cleaning bulletin. (216). McNally Pittsburg Manufacturing Company.

(3) Axiflo Fans

An eight-page booklet describing the economic and versatile performance of the new line of "Axiflo" fans suitable for high temperature applications has been released. Especially significant in the design is the low resistance cone housing that keeps the motor, belts, and all bearings out of the air stream, thereby introducing a great variety of high-temperature applications never before possible with conventional fans. (B-3804). Westinghouse Electric Corporation.

(4) Surface Injury

A new booklet is the most up-to-date and complete treatment available on the subject "Injury in Ground Surfaces." Dr. L. P. Tarasov of the Norton research laboratories is the author. This booklet features many photographs which show clearly the numerous types of defects, such as cracks and burn, that are sometimes found in ground surfaces. Above all, it is written for people concerned with the practical aspects of grinding. This publication should appeal to metallurgists having to deal with these problems since it presents in detail the latest information on the detection of injury and how to proceed in trouble shooting. (508-1P). Norton Company.

(5) Steam Turbines

Orders placed indicate a general acceptance of the preferred AIEE-ASME standards for steam turbine and generator units larger than 10,000 kw. These standards, covering ratings and characteristics, were developed through collaboration between power companies, consulting engineers and turbine manufacturers. Allis-Chalmers' part in this long-range program is told in a bulletin entitled, "Standardized Steam Turbine Units." Carrying illustrations of models of six sizes of standardized units, as well as cross-section drawings, the 16-page bulletin furnishes data on their ratings, capability and pressure and temperature limitations. Ratings are 11,500, 15,000 20,000, 30,000, 40,000 and 60,000 kw. The bulletin also lists the features and accessories to be furnished with the standardized turbine, the air-cooled and the hydrogen-cooled generators, and concludes with a description of the standardized units' excitation system. (03B6801). Allis-Chalmers Manufacturing Company.

(6) Oil Valves

A bulletin on a new self-clean metering oil valve is available. The valve is used on all makes of oil burners. It saves fuel — which is very important today — time, labor and spoilage of material. (707). Hauck Manufacturing Company.

(7) Drawing Compound

Choosing the correct drawing lubricant in order to reduce rejects caused by wrinkling, fracture or poor surface quality and to help assure fine, uniform finishes, is the subject of a special feature article, "Selecting A Drawing Compound," appearing in a recent issue of Oakite News Service. This article discusses the various contributing factors to be considered in making an intelligent selection of a drawing compound. Such drawing compound desirables as cohesion and adhesion, film strength, proper degree of lubrication, wetting-out characteristics, etc., are described in detail. Readers desiring a free copy of the issue of Oakite News Service containing this informative article should circle number seven. Oakite Products, Inc.

(8) Smoke Prevention

To provide commercial and industrial plants with an improved guide on how to design, construct, and install overfire jets for smoke prevention, Bituminous Coal Research, Inc., has published a revised and enlarged issue of Technical Report VII, "Application of Overfire Jets to Prevent Smoke from Stationary Plants." The publication covers the cause of smoke and just how the jet functions to keep smoke formation to a minimum. All example studies are now coupled with drawings showing furnace views before and after overfire jet application. Drawings have also been added to show construction details of popular sizes of steam-air jets built from standard pipe and fittings. (Technical Report VII). Bituminous Coal Research, Inc.

(9) Industrial Brushes

A new brushing catalog, designed to simplify selection of the best brush for the individual job, has just been issued. The new 80-page catalog contains numerous illustrations of industrial brushing operations in addition to photographs and description of a complete line of power, paint, varnish and maintenance brushes. The informative new publication contains many innovations. Many of the photographs illustrate the various types of brushes in actual use. Osborn Manufacturing Company.

(10) Instrument Guide

For instrument men in scientific laboratories and industrial plants, there is available a new 16-page catalog which will serve as a handy guide to all their round-chart Micromax instruments. Called "Micromax Model R — Indicating Recorders and Controllers," this publication is not limited to those instruments used to measure any one quantity, using any one primary element — but, for the first time, it presents all Micromax Model R's, regardless of whether they are supplied to measure temperature, through the use of thermocouples, Rayotubes or Thermohms . . . or other quantities such as frequency, gas analysis, electrolytic conductivity, and pH. Included are complete specifications in easy-to-use, tabular form for automatic indicating recorders, and indicating and recording controllers. Among the recording controllers are instruments which provide two-position control or are integral parts of full proportional control systems . . . the latter either Micromax electric control — position-adjusting type for regulating valves, vanes and dampers, or duration-adjusting type for electrically-heated units — or Micromax pneumatic control. (ND-44-2). Leeds and Northrup Company.

(11) Steel Mill Valves

A 56-page catalog on Okadee valves is ready for you. These valves are suitable for a wide range of applications where low-pressure drop and positive shut off are desirable features. The bulletin tells how these valves, in the interest of uniformity and standardization, have been made interchangeable. Illustrations show how the lever, rack and pinion and worm gear operated type of valves are made by utilizing one type of body. The book is complete with diagrams, dimensions, part numbers, curves and descriptive technical data. Included are installation photographs which show these valves in actual steel plant operation. (47-1). Okadee Company.

(12) Stainless Electrodes

A clear, concise bulletin entitled "What Electrode Would You Use to Weld a Specified Stainless or Alloy Steel?", has been published recently. The subject is divided into sections for easy reference, and provides information on base metal identification of solid and clad materials, recommended types of electrodes, special considerations involving corrosion, heat or strength properties, as well as suggestions for welding dissimilar metals. Also included is a complete chart of the trade names of stainless alloys as produced by the mills of the country. (1047). Arcos Corporation.

(13) Hydraulic Pump

A complete line of radial piston-type hydraulic pumps supplying pressures up to 3000 psi is described in a bulletin just published. Dimensional charts for pumps rated from 1.25 radial gpm to 185 gpm are included, as are characteristic horsepower /volume/pressure curves. Three types of available control are described: constant pressure settings, with or without hand-wheel volume adjustment; automatic reduction of pump stroke at any desired point, and servo-reversing control, which provides infinite control of pump discharge in both directions without changing direction of rotation of the pump. Hydro-Power, Inc.

(14) Heat Treating

A new 24 page booklet, "How to Plan Your Toolroom Heat Treating Department," is available to all interested persons. It is a practical discussion prepared to assist those planning new, enlarged, or changed toolroom heat treating departments. Material in this booklet is based on information gained from helping in the design of hundreds of toolrooms, plus additional information gathered from the experiences of a steel treating company. Lindberg Engineering Company.

(15) Vertical Pump

A new, 20 page bulletin "Vertical Close Coupled Turbine Pumps" is devoted in its entirety to describing and illustrating the specialized application of turbine pumps to installations where short pump settings are encountered and where there is a strong necessity for deep well turbine pump power and capacity in these applications. The bulletin is illustrated with cutaway views of the pump, schematic diagrams of suggested methods of pump installation in various services, in addition to installation photographs of these pumps in a wide variety of industrial applications. Details of pump engineering, construction and operation are also fully described and illustrated. (B-159). Peerless Pump Division, Food Machinery Corporation.

(16) Towmotor Portfolio

A new comprehensive specification portfolio featuring illustrations, engineer's drawings, complete specifications and operating data on all models of Towmotor fork lift trucks and industrial tractors has just been published. The folder will prove of real value to anyone interested in the purchase of materials handling equipment, as it contains all necessary information in compact form for easy filing. The inside covers of the folder are used to illustrate a variety of interesting materials handling operations. A pocket on one side provides a neat file for a smaller, 4-page folder containing condensed specifications on the various Towmotor models in addition to individual specification sheets containing more detailed information on each model. Towmotor Corporation.

(17) Lubricant Injectors

A bulletin is available describing new Type SL-3 lubricant injectors especially designed for use where mounting space is limited. These injectors have only two moving parts, the valve stem and piston, which operate in packings of oil and grease-resisting Linpak material. This type of packing compensates for normal wear that would otherwise result in leakage between metal to metal seals. (801). Lincoln Engineering Company.

(18) Oiler Chart

Featuring 142 actual reproductions of its products, a new two-color wall chart recently made its appearance. Prepared to tell almost at a glance the things a designer or engineer needs to know in general about this manufacturer's line of friction-fighting equipment, the chart measures 24 inches by 36 inches. Most of the items are shown in actual size. Among the different products which are depicted on the chart are constant level and wick feed oilers, threaded and drive type oilers, sight gravity feed and tube oilers, oil and grease seals, sight gages and drip fittings. Gits Brothers Manufacturing Company.

(19) Combination Starter

Read "How the High-Interrupting-Capacity Fuses Provide Short Circuit Protection" in a new publication. It is an 8-page booklet showing construction, operation and application of "Hi-Fuse" combination starter for high-voltage induction and synchronous motors for industry. (192). Electric Machinery Manufacturing Company.

(20) Aluminum

One of the most complete technical helps in its field is an aluminum sheet and plate booklet just released. The booklet, covering 48 pages of technical information relative to various sheet and plate alloys, gages and sizes, was prepared to meet the steadily increasing demand for more information on aluminum sheet and plate and how to use it effectively. It is designed to meet the needs of the experienced user of aluminum as well as to give the newcomer a much clearer insight into the advantages which aluminum has to offer. (5105). Reynolds Metals Company.

(21) Silicone Rubber

New and more complete data on all commercially available types of Silastic, the Dow Corning silicone rubber, are given in Silastic Facts No. 5. Several new types are included among the six Silastic pastes and the six molding and extruding stocks for which typical physical properties including hardness, tensile strength and elongation are given.

Data indicating the inherent stability of silicone rubber include graphs showing changes in physical properties caused by aging at 300 F for 65 days; changes in hardness over a temperature range of –80 to 480 F; brittle points ranging from –70 to –100 F; and tables showing changes in tensile strength, elongation and hardness after 12 months of outdoor weathering. Usefulness of silicone rubber as an electrical insulating material is indicated in tables of dielectric properties and graphs showing changes in dielectric constant and power factor at frequencies ranging from 100 to 100,000,000 cycles per second. Dow Corning Corporation.

(22) Welded Construction

The growing use of welded design and thus the greatly increased value of properly indicating welds on drawings have led a welding supply manufacturer to produce the "Designer's Guide for Welded Construction." This is of such form that it can be placed under a desk glass or thumbtacked to a drawing board for quick reference. Lincoln Electric Company.

(23) Packings

A new catalog section on lines of packings has been published. The section describes and gives data on various types of

Super-heat compressed asbestos sheet packing, rubber sheet packing, cloth inserted packings and Koroseal sheet packing. (5000-9-47). B. F. Goodrich Company.

(24) Thermocouple Wire

A complete line of high-accuracy thermocouple wire for measurement of temperatures in industrial processes and laboratories has been announced by the meter and instrument divisions of the General Electric Company:

Bulletin GEA-4881 lists the various types of thermocouple wires and insulation materials in the new line.

Bulletin GET-1415 gives output characteristics of the common thermocouple-wire materials.

(25) Feedwater Heater

Just published is a bulletin describing and illustrating a newly designed spray-tray deaerating feedwater heater. A distinctive feature of the design is the elimination of the customary vent condenser. Trays and other parts in the heating section are of stainless steel, saving considerable weight and eliminating maintenance. (N-16). Elliott Company.

(26) Chain

The contents of a new 28-page bulletin include comprehensive information on austenitic manganese steel, "the toughest steel known," and its characteristics. Factual data show the advantages and ultimate economy of manganese steel chain for tough jobs involving shock and abrasion . . . heavy duty applications where the most important qualities are durability and freedom from breakdown. The bulletin is conveniently arranged, with the principal applications of manganese steel chain. (742-CN). American Manganese Steel division of American Brake Shoe Company.

(27) Gaseous Oxygen

The availability of a new reprint entitled "The Use of Gaseous Oxygen in Metallurgical Processes" has been announced. Written by Dr. G. V. Slottman and P. M. Hulme, this new 12-page reprint originally appeared in "Metal Progress." The article offers latest information on the metallurgical uses of oxygen in steelmaking, with emphasis on open hearth applications. Air Reduction Sales Company.

(28) Crane Control

A bulletin is available fully explaining a new principle of crane control that eliminates mechanical load brake. Called "Magnetorque," this new a-c crane control provides unusual hoisting smoothness and accuracy. It is a simple unit through which braking forces are exerted magnetically. The control governs the action of the hoist motor which is directly connected through the crane gear train to the hoist drum. The hoist motor drives the load both up and down but cannot be energized until the control unit has been excited. (C-39). Harnischfeger Corporation.

(29) Steel Valves

A new catalog on a full line of forged steel valves is announced. Described is an entire line of 600 lb forged steel valves in gates, globes, angles and checks with various types of trim. These are manufactured in screwed, flanged and socket-weld types. The new catalog describes design and construction, materials, ratings and markings. Forged steel gate valves, union bonnet and bolted bonnet; globe and angle valves, inside screw union and bolted bonnet; globe and angle, O.S. and Y. union and bolted bonnet; check valves, horizontal, lift union and bolted cap are all described in detail in the 16-page catalog. Ohio Injector Company.

(30) Air Motors

A new air motor bulletin has just been released. The bulletin shows the various types of air motors available in four power rated sizes and illustrations of mountings which meet practically every mounting requirement. Also shown are air motor accessories. (BM 20). Bellows Company.

(31) Dew-Point Recorder

A new dew-point recorder and the atmosphere selector are completely described in a new four page bulletin. The bulletin describes the many industrial uses of the dew-point recorder in the heat treat, chemical and food processing industries and also how it is used in connection with the transmission of natural gas. It describes how the recorder automatically records dew point of the atmosphere supplied to it and how the atmosphere selector, which permits multiple atmosphere checking, operates. (TN-121). Surface Combustion Corporation.

(32) Electrical Equipment

All electrical engineers and electrical department supervisors should have in their files a large and complete catalog on "Keystone" electrical material. This catalog includes information on all electrical equipment for traveling electrical contact; industrial haulage and feeder systems; armature repairing; industrial signaling; and many other products for industrial feeders and high-tension power distribution lines. The book is cross indexed both by subjects and list numbers making it easy to find any item desired. Electric Service Manufacturing Company.

(33) Acid-Proof Cement

A bulletin is available describing "Penchlor" acid-proof cement. This cement is a definite and superior sodium silicate cement because it is quick setting and self-hardening, due to the chemical reaction of the ingredients in the mortar. The cement powder is mixed with a sodium silicate solution of definite analysis. Initial set takes place in from twenty to twenty-five minutes after mixing. This cement has a proven record under a variety of acid conditions in steel mills. (6). Pennsylvania Salt Manufacturing Company.

(34) Gear Motor

A bulletin is announced on a gear motor with advanced design for superior performance. In this new motor, all design considerations were worked from the drive point at output shaft back through to the motor, instead of the conventional approach. These motors are available in single, double and triple reductions providing a wide range of speeds with motor rates from one to sixty horsepower. It can be used with any type enclosure of a-c or d-c motor. (C404). Reliance Electric and Engineering Company.

(35) Corrosion Engineering

Data and literature is available to you on a corrosion engineering service. This service can specify and assist in the application of the particular type of lining best suited to solve your problem. Recommendations are made solely with regard to the most efficient method of accomplishing the desired result. If you have a corrosion problem where lining would be a solution it would pay you to investigate this service. Industrial Lining Engineers, Inc.

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(36) Fans and Blowers

Three bulletins are obtainable by you on fans and blowers. The first is a bulletin on "Propeller Fan Wheels," the second on "Wall Fan," and the third on "Turbine Pressure Blowers." All of these bulletins give complete data with illustrations, constructional drawings and tables showing performance and dimensions. (7100, 7200, 1100). Robinson Ventilating Company.

(37) Industrial Baking

A booklet with other literature is available on "Heresite," a solution for metal corrosion problems. Chemical corrosion has long been a serious problem and a tremendous expense, as you may know. Innumerable applications described in this literature will testify to the protection of metals against acids, alkalis, oils, organic solvents and practically all metal corroding substances. Heresite and Chemical Company.

(38) Conveyor Idlers

A bulletin on "Belt Conveyor Idlers" is yours for the asking. The first section of the book is devoted to the proper selection of idlers. Included is a description of a complete line of standard idlers. There is also a section on special application idlers. Belt conveyor accessories are also covered. (463). Chain Belt Company.

(39) D-c Mill Control

A heavy-duty d-c mill control catalog, which includes complete information on the pneumatic timer and its uses, is available. Square D Company.

(40) Roller Bearings

A new engineering journal is now in preparation which will give complete capacity rating tabulations and will also include new bearings introduced since the last publication on this subject. This journal will describe a 25 per cent increase in capacity ratings of Timken bearings. The new rating makes possible the use of smaller bearings with savings in bearing cost, material cost and weight. Timken Roller Bearing Company.

(41) Haulage Solution

Literature is available to you with complete details regarding the newest thing on wheels for steel mill operations. This is a 50-ton diesel electric locomotive designed especially for application in and around steel mills. If you are looking for information on diesel electric locomotives, we suggest that you circle number 41 below. Whitcomb Locomotive Company.

(42) Steel Grid Resistors

A bulletin is available giving detailed information on steel grid resistors which are sturdy, light-in-weight and consistently dependable. (500). Post Glover Electric Company.

(43) Permanent Insulation

A new catalog is available on a complete line of 125 failure resisting wires, cables and cords. This permanent insulation insures long-lived service. (10-F). Rockbestos Products Corporation.

(44) Tubular Rollers

A bulletin has been announced telling how a million tons of hot steel went over carburized tubular rollers without any change in the rollers. (743-19). Badall Engineering and Manufacturing Company.

(45) Steel Castings

Complete details on "Neloy" and alloy steel castings is included in a bulletin available to you. These castings possess machinability, strength, hardness and resistance to shock and wear. (7). National Erie Corporation.

(46) Instruments and Controllers

A catalog on "Instruments and Controllers in Industry" has been announced. This new bulletin tells how these indicating and recording instruments and automatic controls are delivering vital improvements in the making of steel. It tells how these controls save labor and material as well as effecting product improvement. (467-713). Hays Corporation.

(47) Mechanical Picklers

A catalog on "Weldco" mechanical picklers is available. If you are pickling round, hexagon or square bars, coils, flats, tubing or sheets, this mechanical pickler is your best bet to increase tonnage at reduced cost. Easy to operate and control, the picklers save 40 to 60 per cent pickling time by combined mechanical agitation and chemical action, and eliminate the use of an overhead crane and operator. Youngstown Welding and Engineering Company.

(48) Control Valves

Catalogs are available to you on "Quick-As-Wink" control valves. Positive and fast acting with U-shaped packers that are expanded by the pressure, these valves seal tightly preventing leakage and bleeding. All operating parts are in pressure balance eliminating any tendency to creep or crawl. There is no lapping, no grinding, no metal to metal seating. C. B. Hunt and Son, Inc.

(49) Production Marking

A bulletin describing production line marking of seamless or light-wall tubing is available. It will mark round, square, hexagon and other shapes in sizes from 3/8 to 2-in. diameter. It stamps 1, 2, 3 or 4 sides on the same run at the rate of 300 fpm. It is available for production or job work. (LTM-1). Pannier Corporation.

(50) Conditioner

A bulletin is available on a crane cab conditioner designed for soaking pit applications. The balanced refrigeration design prevents overloads in temperature as high as 170 F. This bulletin describes four new models for all types of mill and industrial cranes. (AC-82147). The Lintern Corporation.

(51) Asbestos Gaskets

Catalogs are available to you on asbestos sheets and gaskets. This new material is homogenous in construction and dependable wherever a gasket is required. Every square inch of sheet has a uniform density, thickness and asbestos distribution. Exhaustive tests have shown that this gasket material is suitable for all the temperature-pressure combinations developed in connection with oil and all refrigerants, as well as steam, water, gasoline, ammonia, acids, alkalies and volatile vapors. (115B). Durabla Manufacturing Company.

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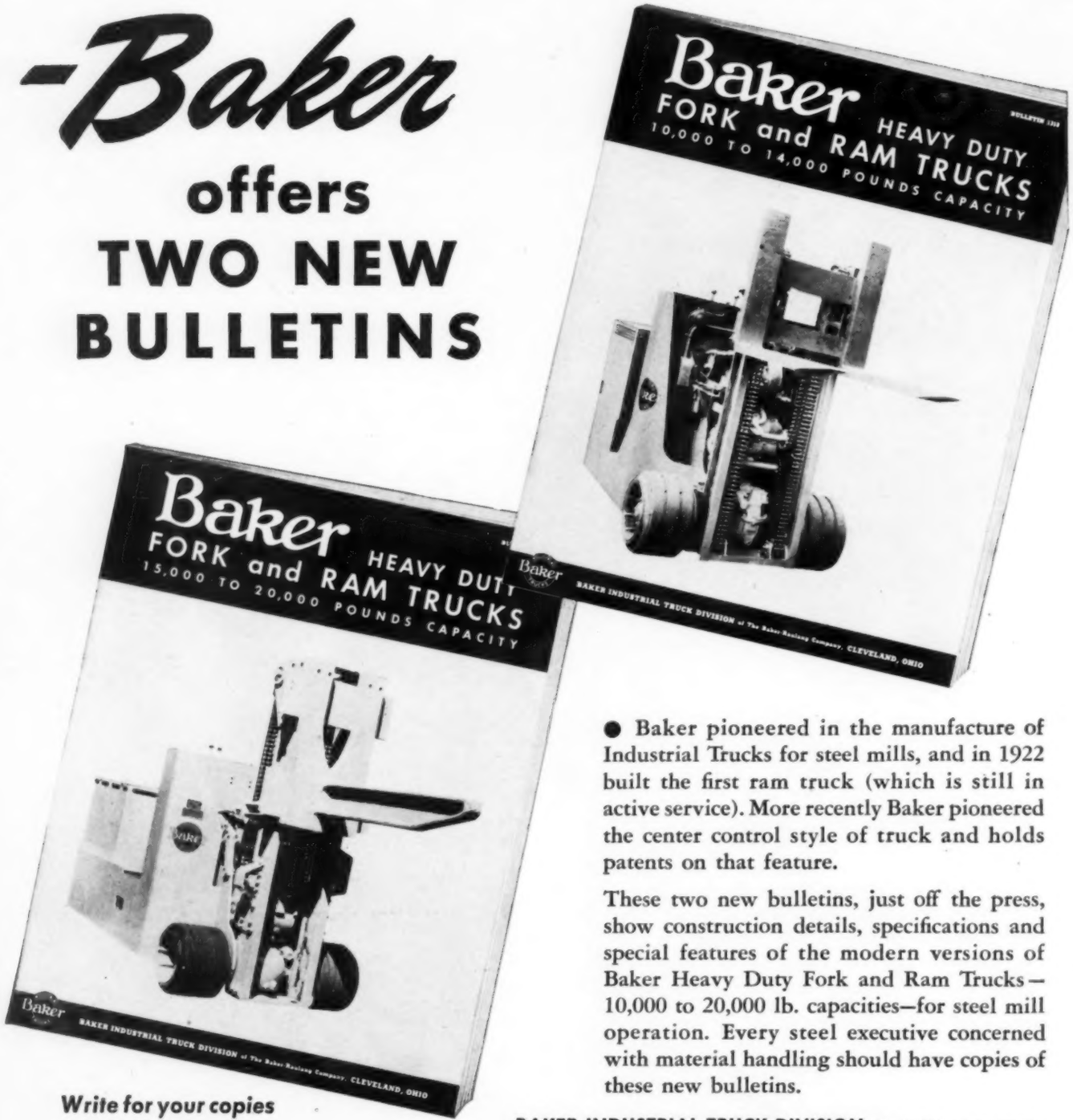

● Baker pioneered in the manufacture of Industrial Trucks for steel mills, and in 1922 built the first ram truck (which is still in active service). More recently Baker pioneered the center control style of truck and holds patents on that feature.

These two new bulletins, just off the press, show construction details, specifications and special features of the modern versions of Baker Heavy Duty Fork and Ram Trucks—10,000 to 20,000 lb. capacities—for steel mill operation. Every steel executive concerned with material handling should have copies of these new bulletins.

Write for your copies of Bulletins 1318 and 1323 today...

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   - (b) Gas-air ratio
   - (c) Stove dome temperature

BESSEMER

1. AIR FLOW OR AIR PRESSURE CONTROL
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2. LOAD DISTRIBUTION
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4. FURNACE DRAFT REGULATION
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6. FLOW RECORDERS

OPEN HEARTH AND HEATING FURNACES

1. HEAT INPUT CONTROL
2. ROOF TEMPERATURE CONTROL
3. FURNACE PRESSURE CONTROL
4. FUEL-AIR RATIO CONTROL
   - (a) Oil Firing
   - (b) Gas firing
5. REVERSAL CONTROL
6. DRAFT AND PRESSURE RECORDERS
7. FLOW METERS
8. B. t. u. METERS (Mixed fuel Firing)

SOAKING PITS

1. TEMPERATURE CONTROL
2. FUEL-AIR RATIO CONTROL
   - (a) Oil firing
   - (b) Gas firing
3. FURNACE PRESSURE CONTROL
4. GAS PRESSURE CONTROL

HEATING FURNACES

1. HEAT INPUT CONTROL
2. FUEL-AIR RATIO CONTROL
   - (a) Oil-firing
   - (b) Gas firing
3. FURNACE PRESSURE CONTROL
4. GAS PRESSURE CONTROL

GAS DISTRIBUTION SYSTEMS

1. GAS PRESSURE REGULATION
2. MIXING STATIONS
3. SEQUENTIAL DISTRIBUTION CONTROL
4. PRESSURE STABILIZATION CONTROL
5. BLEED CONTROL
6. GAS FLOW METERS

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

HAGAN CORPORATION
Hagan Building
Pittsburgh 30, Pa.

METALLURGICAL FURNACE CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
BOILER COMBUSTION CONTROL SYSTEMS

News Supplement

(*Continued from page 112*)

▲

INSTRUMENT ASSURES UNIFORM QUALITY

▲ Development of a revolutionary instrument which makes possible accurate and close control of low-temperature processing was announced recently. The new instrument is a low-temperature radiation pyrometer which has been tested in rubber and plastic mills and in continuous curing ovens and paint pigment kilns. The tests have shown that low-temperature radiation control reduces rejects, speeds output, assures uniform quality and reduces power losses.

Control of low temperature through radiation pyrometry is especially useful where the measuring device does not or cannot come into contact with material or processing equipment. The same principle has been used for years, he said, for extremely high temperature measurement and control.

The Brown Instrument Company development is said to be another example of applying to industrial operations the techniques which until now have been mostly confined to the laboratory.

COUPLING CONNECTIONS MADE WITH EASE

▲ A line of couplings whose principal feature is quick-connection or disconnection is announced by Hansen Manufacturing Company. This coupling has straight through flow with smooth, unrestricted bore. Sealing is accomplished by an "O" ring. The two component parts of the coupling, socket and plug, are joined by moving the socket sleeve slightly, pushing the plug into the socket, and then releasing the sleeve. The sleeve is actuated by spring pressure. A ball locking device is used. Both sockets and plugs are made in sizes ranging from ¼ in. to 2½ in. with male and female nominal pipe thread connections and ¼ in. to 1 in. hose stem connections.

A typical application is at the hose terminals where lubricant lines are connected to roll neck bearings of rolling mills. On mills not Hansen equipped it is necessary for the workman to stand in an oil-soaked pit to connect or disconnect the hose lines. Connections on hose lines equipped with Hansen quick-connective couplings are made by hand from the floor level.

The two component parts are joined by moving the socket sleeve slightly, pushing the plug into the socket, and then releasing the sleeve.

Hansen also manufactures a complete line of quick-connective couplings which have a valve in the socket, or in both plug and socket. These valves open automatically when plug and socket are joined, and close instantly when they are disconnected.

STEAM JETS USED IN WEIRTON STRIP PICKLERS

▲ Steam jets heat and agitate the sulphuric acid to pickle 80,000 to 125,000 tons of strip steel per month in each of the Weirton Steel Company's continuous strip pickling lines. In these strip picklers the urgent demand for faster more uniform pickling has been accomplished, as in many other mills, by employing the newer E-3 jets, built by the Heil Process Equipment Corporation.

Time is a factor to be reckoned with in every processing operation. In Weirton's continuous pickling lines, it expresses itself as four tanks, each 80 ft long. The question of how best to obtain the optimum temperature uniformly throughout the entire length of these four 80 ft tanks is answered successfully with the manifold and jet design incorporated in the jets. With this arrangement each tank requires only four steam connections that feed 120 nozzles, set on approximately 15 in. centers.

In this way every foot of this 320 ft line is positively heated to the optimum temperature established by the operating department and is maintained at that temperature at all times by suitable temperature regulating equipment.

The lead alloys used in special extruded structural sections are the only economical material engineers have found to stand up under the rigorous conditions of heating service in these modern continuous pickling lines. These lead alloys are ductile, strong, practically inert; in fact, it is unattached in sulphuric acid at the temperatures and concentrations used. Furthermore, the jets do not become brittle or fragile.

These jets are built extra heavy for long life and low maintenance. The manifold walls are of special heavy lead alloy. The nozzles are of carbon, chemically inert and unusually abrasion resistant to the high velocity steam. These nozzles are anchored and reinforced in place by special patented structural features. The jets used are designed to operate at steam pressures up to 80 psi. Where comparison tests have been run these steam jet agitators show an increase of 20 to 30 per cent in the speed or tonnage pickled, and approximately a 10 per cent saving in acid consumption.

Field tests have shown that (outside of acid concentration) two factors are most effective in accelerating the removal of scale. These are acid temperature and the scouring action of agitation.

Local conditions of equipment or operating experience establish temperature limits. In any case, other

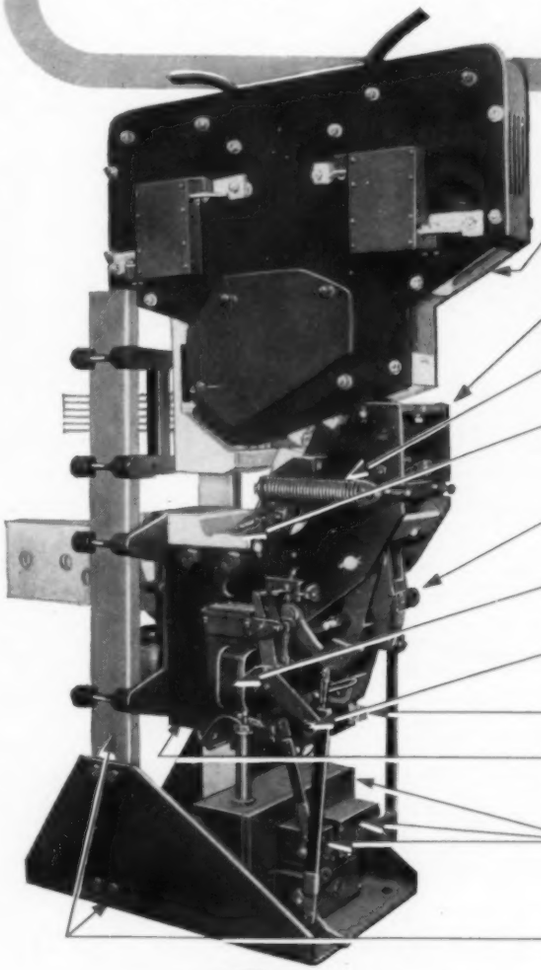
PROTECT VITAL PRODUCTION EQUIPMENT WITH THIS *Better designed-Better built* BREAKER

Short circuits and the extremely heavy overcurrents encountered in electrical distribution systems of Rolling Mills and Electrolytic plants can ruin essential generators, motors, rectifiers, and related equipment. This, and the resultant production shutdowns, and repair or replacement bills, cut deep into operating profits. I-T-E—specialists in quality Switchgear—give you *more effective, more dependable* protection from electrical disturbances with the better engineered Type MT Circuit Breaker.

Especially developed for interrupting extremely heavy direct-currents, the MT breaks a circuit in .028 seconds, (about 1¾ cycles on a 60 cycle basis) at 25% to 100% of interrupting capacity. Short circuits and overcurrents are cleared instantly, dependably. The MT is a single pole, electrically operated, D-C breaker designed for 250 and 750 volt service. Interrupting rating is 150,000 Amp. for 2000 and 4000 amperes continuous ratings, and 250,000 Amp. for models continuously rated 6000, 8000, 10,000 and 12,000 amperes. Further information on the MT is contained in catalog 2201. Send for it today.

The I-T-E representative in your locality will be glad to advise you on applying the MT—and other I-T-E protective equipment—to your electrical distribution system. Use his services without obligation.

NOTE THESE RUGGED, EFFECTIVE CONSTRUCTION FEATURES OF THE MT



MAGNETIC ARC CHUTE of large thermal capacity drives gas and arc upward for safe extinction. Arcing time is extremely short with either light or heavy currents.

SELF-ENERGIZING BUFFER MECHANISM smoothly absorbs shocks of opening—prevents sticking or bouncing.

HEAVY-DUTY OPENING SPRINGS are mechanically loaded while breaker is closed. Trip devices act directly on holding toggle for instantaneous opening.

LOWER STATIONARY MAIN CONTACT BLOCK—Main contacts are silver base inserts backed with solid blocks of copper. Silver base inserts assure contacts free from oxidation and overheating.

SIMPLE MECHANICAL SYSTEM includes a light-loaded roller-bearing latch for low friction and fast tripping.

SHUNT TRIP COIL allows remote electrical opening—by hand, by a relay, or by auxiliary switch on another breaker.

HAND TRIP BUTTON is provided to allow normal opening of the circuit at the breaker.

OPERATION COUNTER mounted on each breaker as a standard device.

CLOSING SOLENOID HOUSING—Metal enclosure protects the closing coil against corrosive mill atmosphere.

ACCESSORY DEVICES—Terminal box for control wiring, and multi-contact auxiliary switches for shunt trip coil and signal lamps, are conveniently located near base of breaker with ample space for control wiring.

SUPPORTING POST AND FABRICATED STEEL BASE—Entire frame of hot-rolled steel, formed and welded into a rugged, protective support unit.

I-T-E

MILL TYPE SWITCHGEAR

The Leader In Technical Excellence

I-T-E CIRCUIT BREAKER CO., 19th & HAMILTON STS., PHILADELPHIA 30, PA.—31 OFFICES IN UNITED STATES AND CANADA

SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • AUTOMATIC RECLOSING CIRCUIT BREAKERS • HIGH SPEED CIRCUIT BREAKERS

things being equal, higher acid temperature offers opportunity for faster pickling and greater tonnage. It is standard practice to increase temperatures as the iron content increases to the point of disposal. It is, therefore, important to have heating units that will respond to varying operating conditions and the demand at times for extra heat to maintain schedules.

Weirton operates with 20 to 30 per cent sulphuric acid boiling. These jets easily maintain the temperatures they establish in each of these 13,000 gal acid tanks.

In some respects pickling operations may be regarded as controlled corrosion. In the study and selection of materials to serve under varying conditions a major consideration is always the degree of turbulence or agitation since this greatly influences corrosion rates. Taking advantage of this, Heil engineers designed the steam jets for these lines to so vigorously agitate the pickle that the acid film is repeatedly swept from the steel surface and replaced with fresh acid. In this way, the agitation brings fresh acid in contact with the surface and further assists the action of the acid by a scrubbing action.

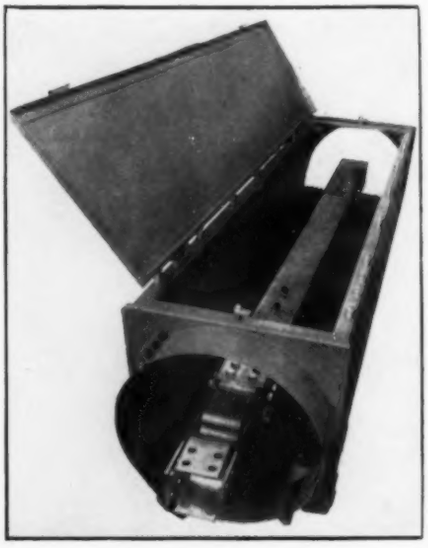
It has been demonstrated that even at high strip speeds the adjacent liquor film tends to sweep through the acid with the strip. The jets dislodge this film. Jet nozzles are spaced approximately every 15 in. and directed at 90 degrees to the direction of strip travel. In this way they effectively break up clinging film and induce the scrubbing action. Nozzles are located along opposite sides of the tank. On one side they are directed upwards and on the opposite side they are directed across the tank, thus producing a rotary turbulence. Nozzles may be oriented to any angle for best results. This scrubbing action is continuous, even during periods of "steam off." This is accomplished by low pressure air, through a simple assembly of fittings and valves with temperature control.

In this way without any moving parts, the acid is adequately heated and agitated, giving the hot rolled steel a uniform finish.

ISOLATED-PHASE BUS FOR SAFE INTERCONNECTIONS

▲ A new aluminum-enclosed isolated-phase bus run for safely interconnecting generators, transformers, and switchgear equipments has been announced by the switchgear divisions of the General Electric Company. The equipment is available for 15-kv applications in current ratings of 1200, 2000, 3000, 4000, and 5000 amperes, and has a basic impulse level of 110 kv. It is dust-tight and weathertight, and may be used for indoor or outdoor installations. It is tested and assembled to meet AIEE and NEMA standards.

Each phase of the bus run has a single aluminum sheet shaped to form three sides of the housing. The fourth side consists of a gasketed and clamped cover which is hinged to avoid the necessity of handling loose covers when inspecting the bus.



Sections of the bus are shipped completely assembled reducing installation expense.

Installation expense is reduced because sections of the bus are shipped completely assembled. End bells of adjacent sections are connected by split aluminum bands having gasketed mating flanges. In addition to making a tight joint, the gasket arrangement breaks up circulating current paths.

To form a length of three-phase bus run, three housings are bolted to cross members made from aluminum H-beams. The steel plate brackets supporting the insulators are braced apart by these same cross members. Necessary structural steel members for attaching the H-beams to the building structure are supplied.

METAL MAKERS GUILD TO HOLD JUNE MEETING

▲ The Electric Metal Makers Guild, Inc. will hold its sixteenth annual meeting at Bethlehem, Pennsylvania, June 16, 17 and 18, 1948. Among the papers to be delivered are, "Fundamentals in Steel Melting," by Dr. C. H. Herty, Jr. of Bethlehem Steel Company and "Hydrogen and Nitrogen Contents of Steel" by C. E. Sims of Battelle Memorial Institute.

The annual banquet of the Guild will be addressed by J. M. Sylvester, general manager, Bethlehem Plants, Bethlehem Steel Company.

R. H. Frank, Bonney Floyd Company, is president of the Guild; A. J. Scheid, Jr., Columbia Tool Steel Company, is vice-president and D. L. Clark, Simonds Saw and Steel Company, is secretary-treasurer.

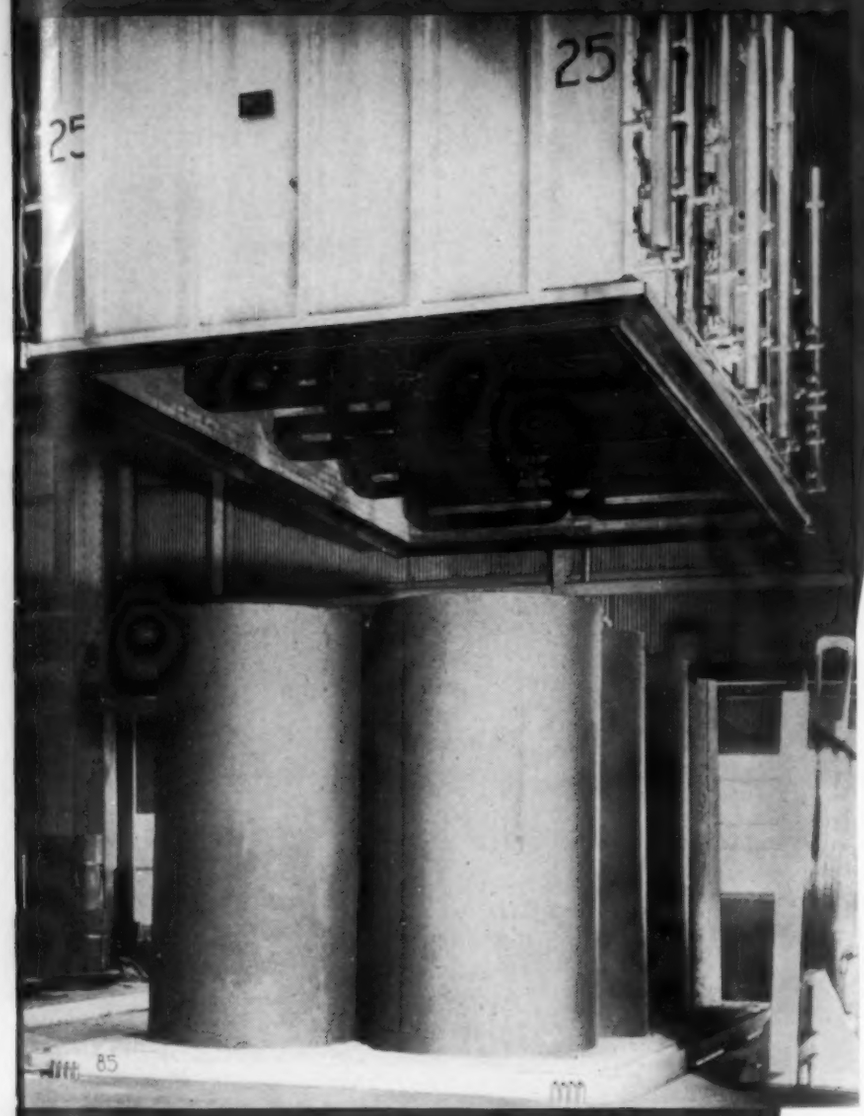
CLASS B INSULATION ON TRANSFORMERS

▲ Dry type class B insulated load center transformers for plant power distribution circuits are now being built by Wagner Electric in the following ratings: Three-phase, 60-cycle, 100 to 2000 kva, with high voltages of 2400, 4160, 4800, 7200, 12,000, 13,200, or 14,400, and low voltages of 600, 480, 240 or 208Y/120. All are rated 80 C rise, with natural ventilation.

Transformers are housed in paneled enclosures designed for indoor installation. Matching compartments for primary and secondary switchgear can be furnished as required, to form complete, closely-coupled unit substations. Removable panels facilitate cleaning and inspection, and complete enclosure of all equipment safeguards against accidental contact with live parts.

Efficient cooling of the core and coils is accomplished by exposing as much radiating surface as possible to the air. Vertical ducts through the core and vertical and horizontal ducts through the winding provide maximum ventilation and reduce internal temperatures.

Insulation materials are mainly class B; class C materials are used where extra strength is needed. Coil conductors have double servings of fiber glass. Successive baked coats of heat resistant synthetic varnish give the windings a tough high gloss finish.



Leadership at work!

ONE of **16 COIL FURNACES** installed in a large Midwestern plant—

plus

10 FLAT SHEET FURNACES installed at the same time

SWINDELL-DRESSLER

RECIRCULATING RADIANT TUBE

In this large Swindell-Dressler installation, each 40-tube furnace is capable of annealing eight stacks per base of sheet steel in 72" O.D. diameter coils, stacked 150" high —aggregating 600 tons of metal per heat.

Let a Swindell-Dressler Engineer consult with you regarding your particular furnace requirements—on any scale, anywhere.

SHEET ANNEALING FURNACES

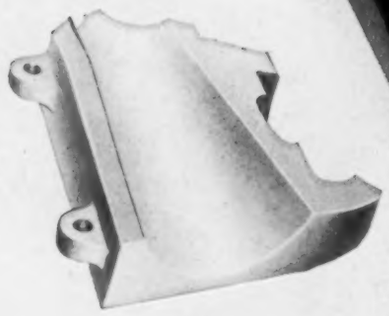
SWINDELL-DRESSLER Corporation

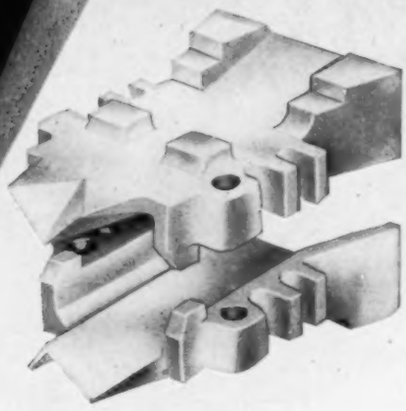
DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES

PITTSBURGH 30, PA.

TRANTINYL

GUIDES THE STEEL INDUSTRY



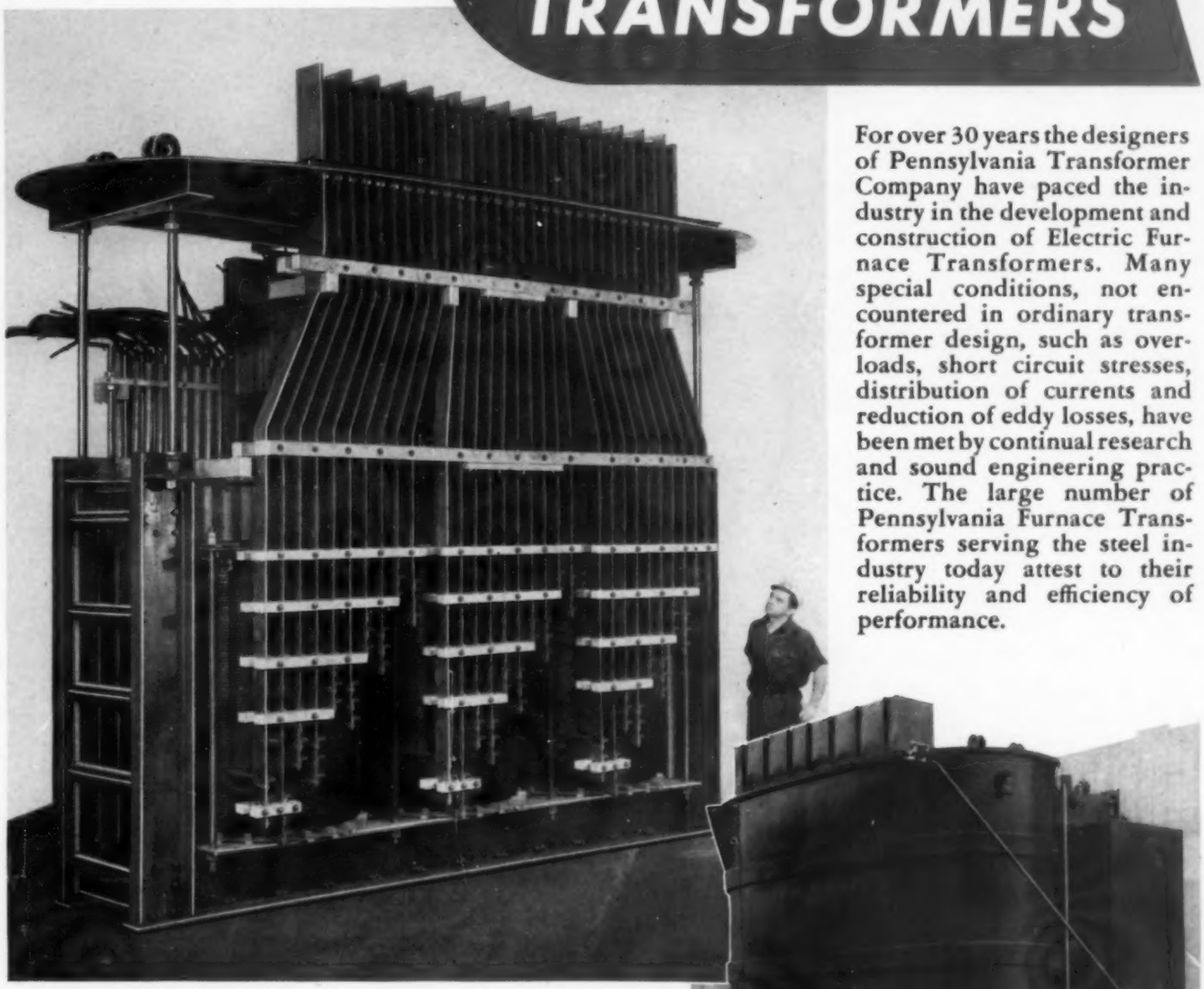


PRODUCTION · QUALITY · YIELD

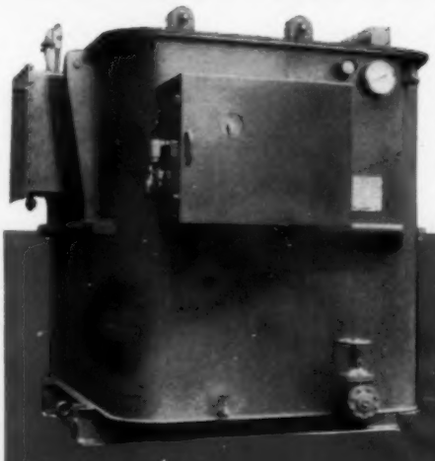
YOUNGSTOWN ALLOY CASTING CORPORATION

YOUNGSTOWN 1, OHIO

Iron and Steel Engineers prefer PENNSYLVANIA FURNACE TRANSFORMERS



For over 30 years the designers of Pennsylvania Transformer Company have paced the industry in the development and construction of Electric Furnace Transformers. Many special conditions, not encountered in ordinary transformer design, such as overloads, short circuit stresses, distribution of currents and reduction of eddy losses, have been met by continual research and sound engineering practice. The large number of Pennsylvania Furnace Transformers serving the steel industry today attest to their reliability and efficiency of performance.



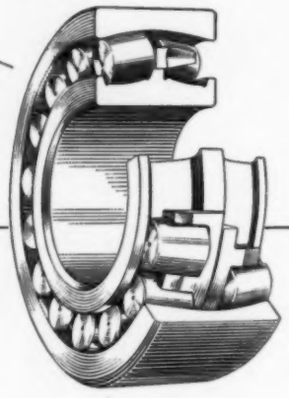
TOP 7500 Kva, 3 Phase, 25 Cycles, 40° C Rise, 12,000-240 volts, 33,300 Amperes.
RIGHT 7500 Kva Transformer mounted on flatcar for shipment.
LEFT 7500 Kva, 3 Phase, 60 cycles, OIWC, 13,200—255 volts

Pennsylvania TRANSFORMERS

Pennsylvania
TRANSFORMER COMPANY
808 RIDGE AVE. PITTSBURGH 12, PENNA.

Better Table Roll Performance with Torrington Spherical Roller Bearings

Torrington Spherical Roller Bearings on table rolls provide low friction coefficient, high radial capacity, axial stabilization, and self-alignment for improved performance and easy mounting.



. . . table rolls equipped with self-aligning bearings operate dependably, help increase production and reduce maintenance costs.

IN MANY WAYS, high-capacity Spherical Roller Bearings help assure more profitable operation in runout tables. Not only are higher speeds and loads possible, but longer service life is secured with minimum maintenance. Because Spherical Roller Bearings take thrust loads, too, end play of rolls is eliminated . . . bevel drive gears mesh accurately . . . wear is reduced. The self-aligning feature prevents development of unusual stresses under deflection . . . facilitates mounting with assured shaft alignment.

These are only a few of the benefits resulting from the use of compact Torrington Spherical Roller Bearings on screw downs, gear trains, table rolls, take-up reels, pinion stands and other auxiliary steel mill equipment.

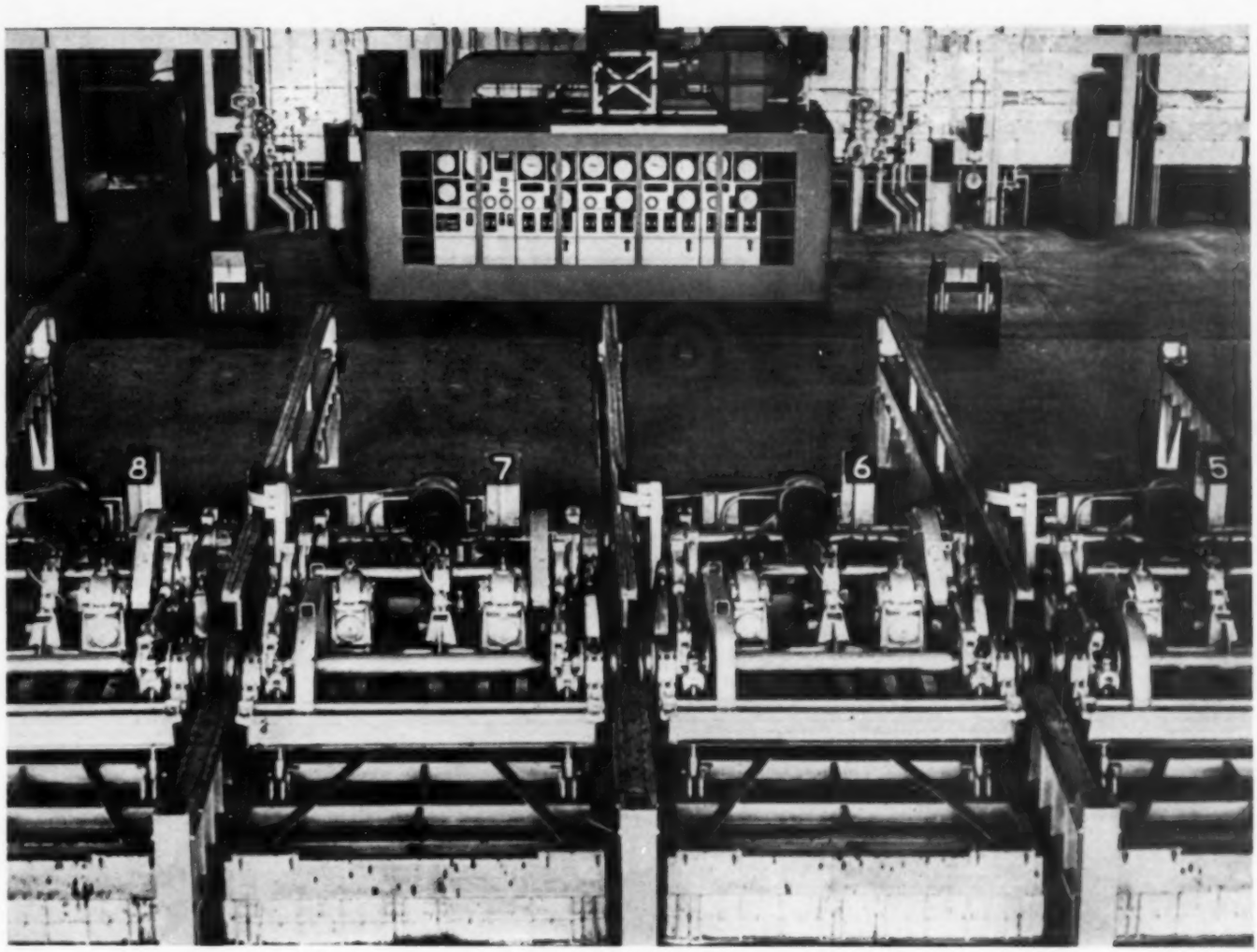
For assistance in selection and design of anti-friction bearing applications in your heavy-duty equipment, and for close follow-up service, call on Torrington's engineers. Call or write the nearest Torrington office.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District Offices and Distributors in Principal Cities

TORRINGTON SPHERICAL ROLLER **BEARINGS**

SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • NEEDLE • BALL • NEEDLE ROLLERS

Modern Soaking Pit Control



Brown Soaking Pit Control Systems assure rapid uniform heating of ingots under proper scaling conditions. Many unique features contribute to increased tonnage and faster drawing operations.

The *ElectroniK* "Continuous Balance" Potentiometer maintains precision temperature control from either thermocouple or Radiamatic measuring elements.

Automatic fuel cut-off from cover opening is accomplished by immediate shut-off of the temperature control valve. Rapid regain of temperature after cover replacement provides fastest drawing operations.

Maximum fuel rates, or intermediate soaking periods can be easily established at the control panel. Completion of soaking is indicated by a simple signaling system.

Brown Air-o-Line Control systems provide simple, safe, fast and dependable control action.

Engineering Bulletin SM-1 "Instrumentation and Control of Recuperative and Direct Fired Soaking Pits" gives complete information. Write for your copy today.

THE BROWN INSTRUMENT CO., 4464 WAYNE AVE., PHILADELPHIA, 44, PA.

DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.

Offices in principal cities of the United States, Canada and throughout the world

BROWN *Advanced Instrumentation* **FOR BETTER PROCESSING**

Product of MINNEAPOLIS **Honeywell**

IT'S ALL-ALUMINUM

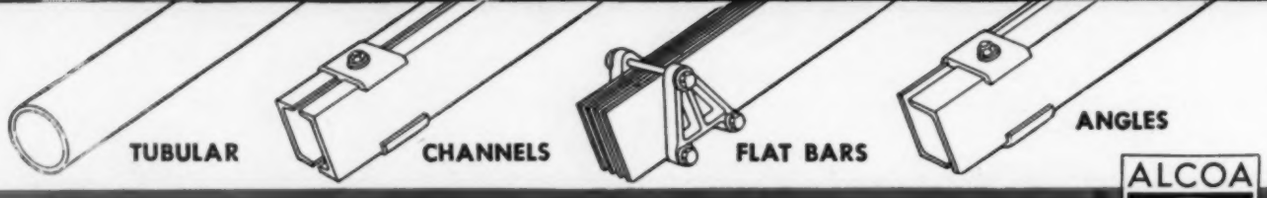
THE BUS:
8" dia. Alcoa Aluminum Tubular Bus

THE WELD:
Inert-arc... No Flux

There's only one thickness of metal at the welded joints in this 8-inch tubular bus conductor of Alcoa Aluminum. Freedom from overlaps and bolted fittings gives additional space saving.

You get maximum current-carrying efficiency through welded *all-aluminum* joints. There's no danger of high resistance between connecting surfaces, no flux to cause blowholes, slag pockets, or corrosion in the joint.

Ask us for information and engineering data to help you design with Alcoa Aluminum Bus Conductors. And we'll tell you how to weld aluminum, too. ALUMINUM COMPANY OF AMERICA, 2128 Gulf Building, Pittsburgh 19, Penna. Sales offices in 54 leading cities.



ALCOA ALUMINUM BUS CONDUCTORS

ALCOA ALUMINUM

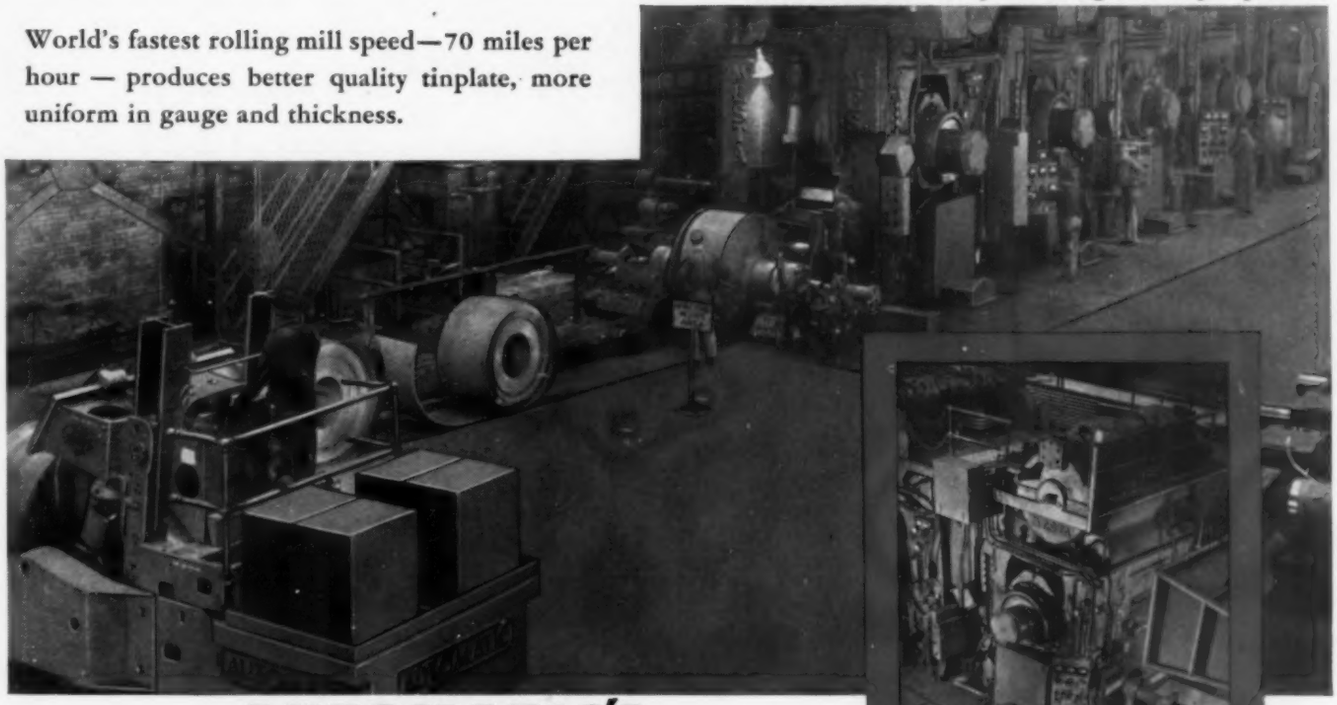
IN EVERY COMMERCIAL FORM

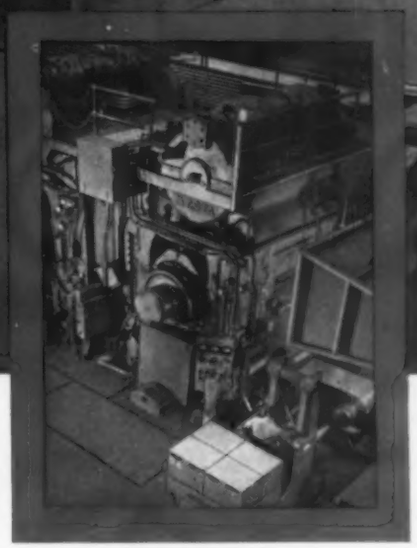
JONES & LAUGHLIN NEW, MIRACULOUS HIGH SPEED COLD STRIP MILL

*Reduces 30,000 Pounds of Steel Into 6 Miles of Tinplate IN 5 MINUTES!**

***When mill is operating at top speed.**

World's fastest rolling mill speed—70 miles per hour — produces better quality tinplate, more uniform in gauge and thickness.





AUTOMATIC'S Skylift GIANTS

Feed and Discharge Coils of Unlimited Size and Weight

Coils of hot rolled strip from the new continuous pickle line are carried to the entry end of the new five stand tandem mill at the Aliquippa Works, Jones & Laughlin Steel Corporation. Weighing as much as 30,000 pounds, the coils are carried by Skylift GIANTS to a ramp, and fed into the entry end. Because of the continuous high speed at which it is squeezed between heavy steel rolls, the steel strip is of more uniform gauge.

Thus, steel mills no longer are limited in speed by size of coils that can be delivered to and discharged from the mill—Automatic Skylift GIANTS are specially engineered to handle all sizes, all weights.

Four front drive wheels provide as much as 80 inches of rubber. Pivoted drive axles give constant 4-wheel traction regardless of floor conditions—controlled caster type trail axle, center-pivoted, compensate for uneven floor surfaces. Nearly 20% lighter in proportion to load capacity than other heavy-duty fork and ram tractors—Skylift GIANTS are the only heavy-duty trucks with HIGH PRESSURE HYDRAULIC LIFT that eliminate chains and sprockets.

Mail coupon for facts about how Skylift GIANTS offer *your business* amazing production and handling savings.

Skylift GIANT
A PRODUCT OF AUTOMATIC
Lightens LIFE'S LOADS

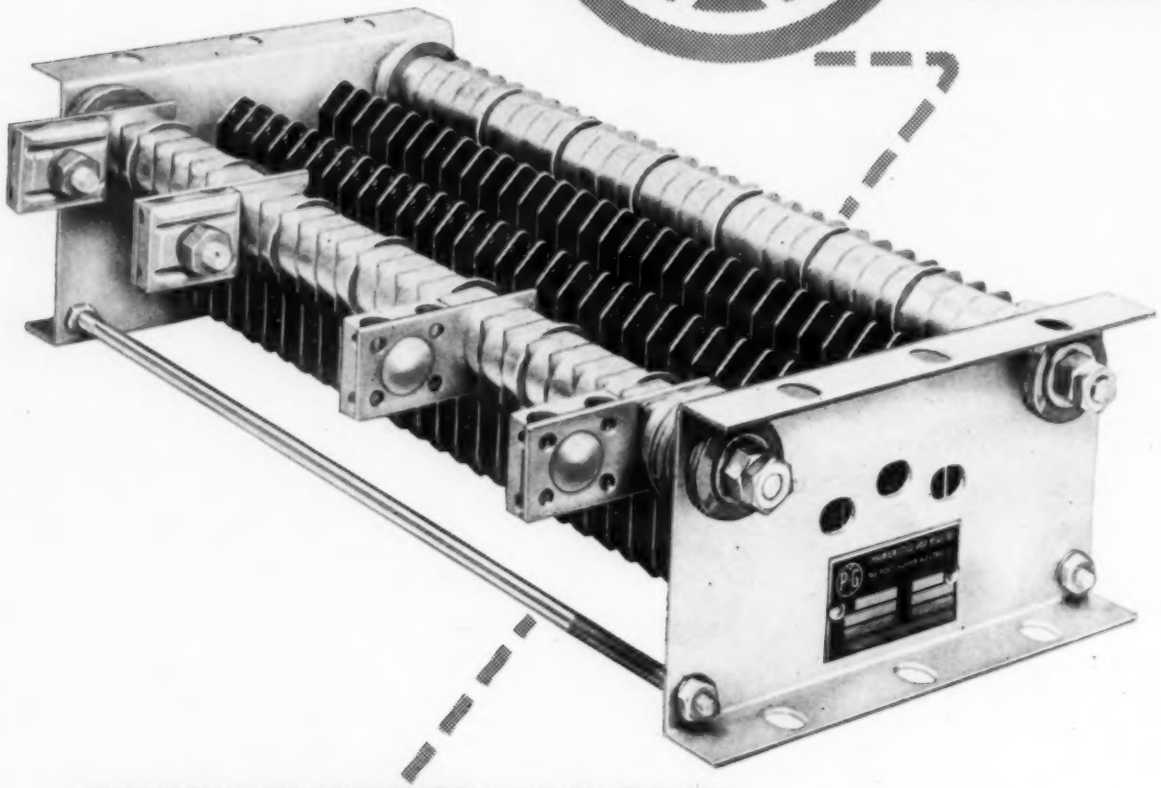
AUTOMATIC TRANSPORTATION COMPANY
DIV. OF THE YALE & TOWNE MFG. CO.
47 W. 87th Street, Dept. E-8, Chicago 20, Ill.

( ) Send details on Automatic's Skylift GIANTS Fork and Ram Trucks.
( ) Have an ATCO Specialist make a free survey of our material handling costs.

Company Name.....
By .....
Street Address.....
City.....Zone.....State.....

INDIVIDUAL RESISTOR REQUIREMENTS *Solved...*

with *Nonbreakable* P-G STEEL GRID RESISTORS!



QUICK CHANGES ARE EASY...

Little effort required to make adjustments.

- Minor variations often possible by wire change to other available terminals.
- Greater variations easily produced by movement of terminal position in the unit.
- Major variations effected by removal or addition of one or more standard banks.

For minimum maintenance and maximum production, specify P-G.

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

This CATALOG should be at your fingertips

"Fight Friction" contains engineering data which will help you get longer and more economical bearing service

Plant operating men, as well as product designers who are concerned with problems relating to non-ferrous bearings or castings, can use this 16-page booklet to advantage. It contains descriptions, physical properties and specifications of N-B-M Babbitt metals — bronze cored and solid bars and parts. Instructions for successful re-babbitting with N-B-M Babbitt Metals are also included.

The metals described are the result of three-quarters of a century of anti-friction research.

Improved production and alloying techniques are used in making these better N-B-M Bearings and Castings. Competent, experienced engineers are ready and able to help you wage the "war on wear"— help you solve design, alloy, stress loading lubrication, or even more complex problems.

If you're interested in reducing maintenance costs or in increasing the service life of bearings and castings, write for your copy of "Fight Friction" today.

NBM

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION
ST. LOUIS • NEW YORK

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

THE ENGINEERING MART

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POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

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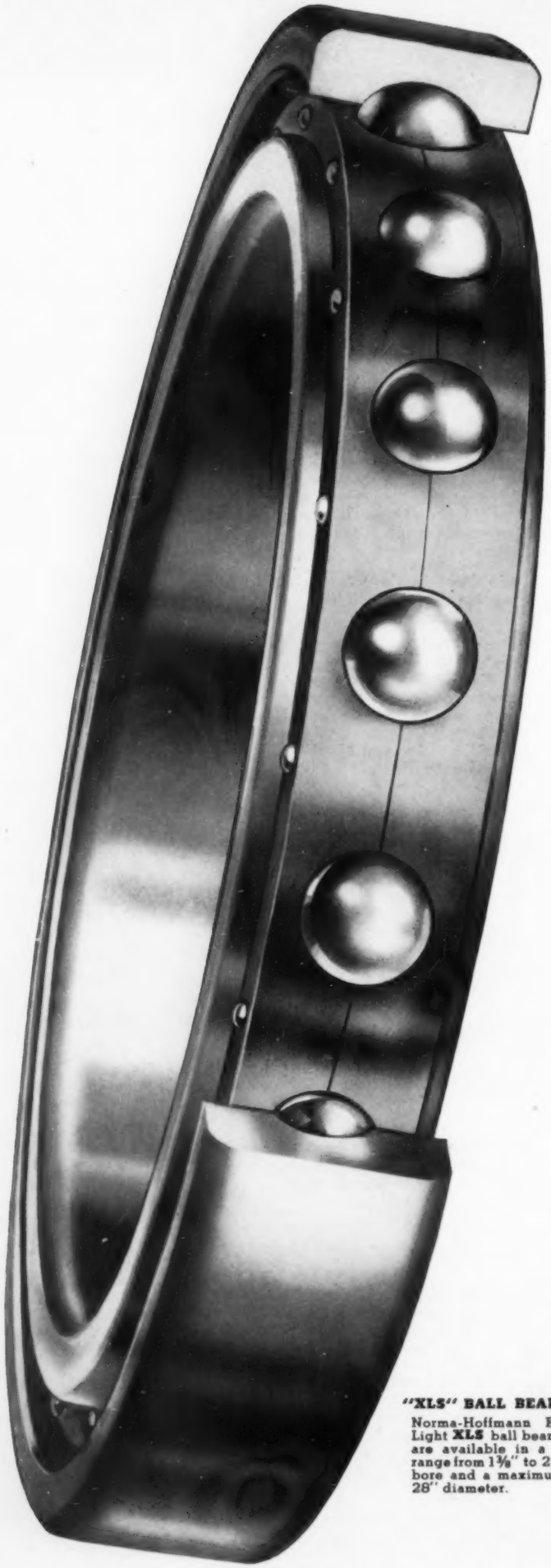

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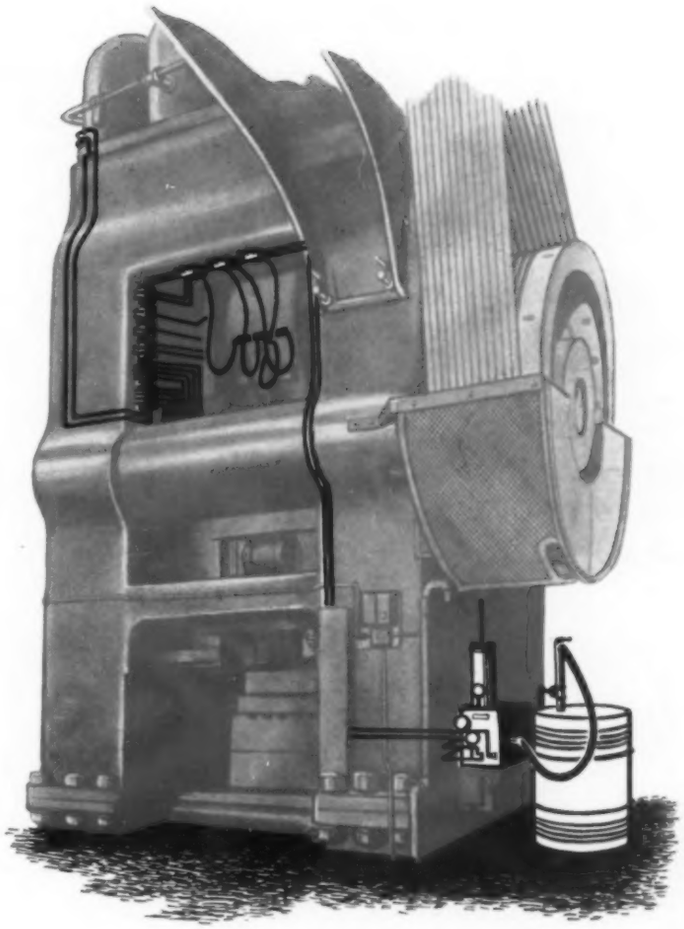

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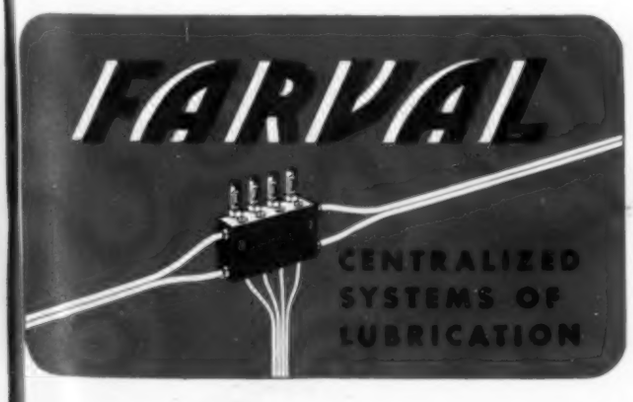

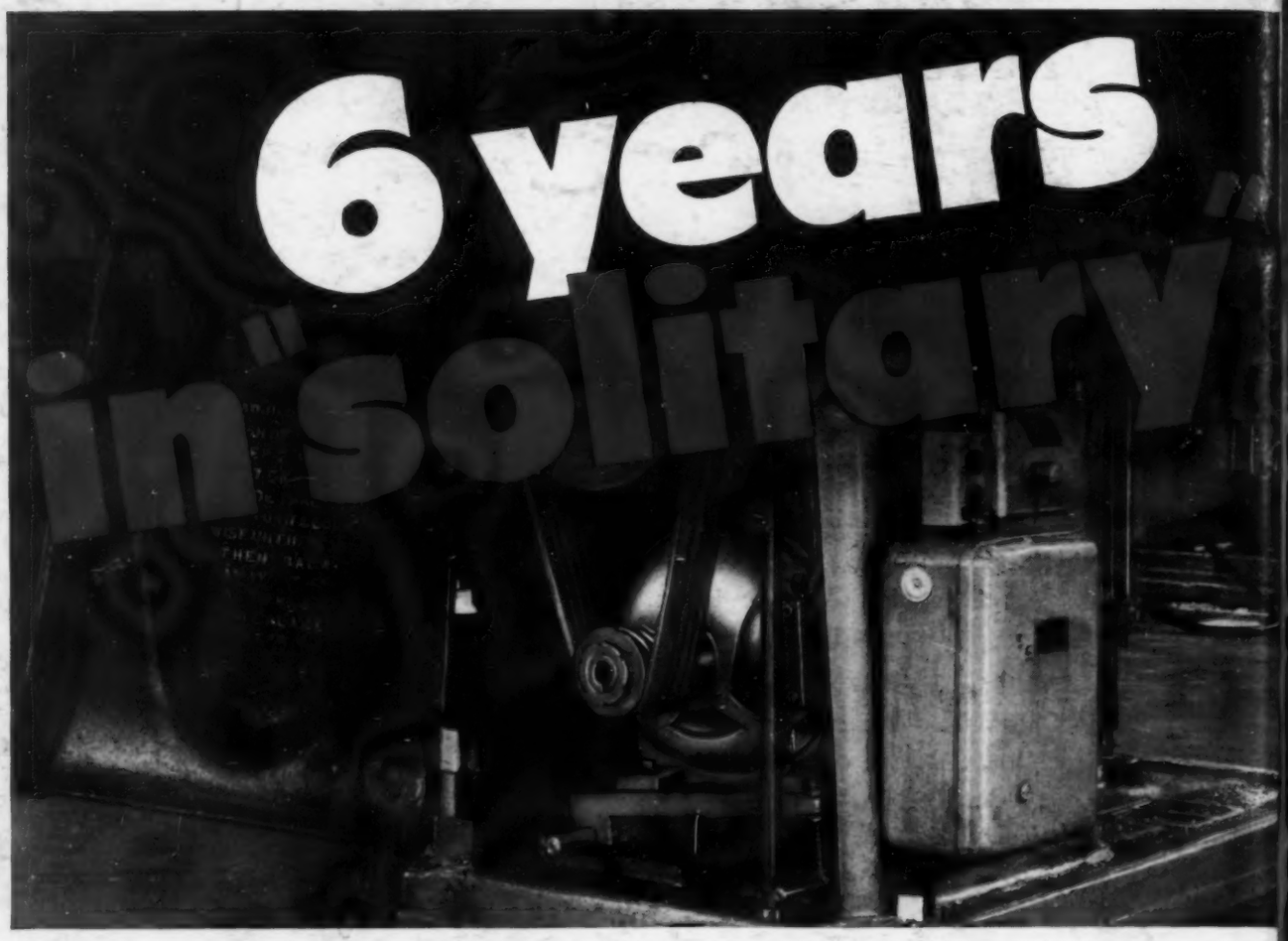

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